United States Court of Appeals

for the Second Circuit

EXHIBITS

76-7207

United States Court of Appeals

For the Second Circuit

Docket No. 76-7207

PRUDENTIAL OIL CORPORATION,

Plaintiff-Appellee,

vs.

PHILLIPS PETROLEUM COMPANY,

Defendant-Appellant.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF NEW YORK

(67 Civ. 3748 (C.L.B.))

EXHIBITS FOR JOINT APPENDIX

Volume VI — E1414 - E1729

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(ED. 4-23-71)

E 1414

PLAINTIFF

EXHIBIT

U. S. DIST. COURT
S. D. OF N. Y.

217

FPI NI—9-24-75 50M-4417

ALGERIAN CRUDE
PUERTO RICAN
PETROCHEMICAL COMPLEX

BEST COPY AVAILABLE

cc: Messrs. Stanley Learned (attach)
W. W. Keeler (attach)
G. W. McCullough
P. J. Parker (attach)
E. H. Lyon (attach)

P 217

E 1415

September 24, 1963

Messrs. T. L. Cubbage
H. W. Hinkle
W. F. Martin
C. C. Tate
R. W. Thomas

PLF DEPT EX 249 FOR ID. B. JACOBS 1/16 19 73

Gentlemen:

Attached is a copy of a report from G. W. McCullough to P. J. Parker relative to the practicality of an Algerian Crude Oil - European Refinery - Puerto Rican Petrochemical Complex. You gentlemen together with employees of your departments have contributed substantially to this study.

The Sales and Development Division of the International Department believes that the results of this preliminary investigation justify substantial expenditure of money and manpower for intensified study of the project. Plans are now being made for the necessary marketing surveys required for both refined products and petrochemicals.

We request information from your departments as follows:

Chemical Department -- Please prepare an analysis of the petrochemical portion of the attached report giving your views on the proposal as outlined and making any recommendations which you may have for modification of the proposal. Please make recommendations as to market survey requirements for petrochemicals.

Comptrollers Department -- Please advise us of taxing provisions in Puerto Rico and make recommendations concerning means by which Phillips can take maximum advantage of these provisions.

Treasury Department -- Please review the project from a financial standpoint and also advise us of interest rates on borrowed money in Europe, Algeria and Puerto Rico.

Manufacturing Department -- Please offer your comments concerning all phases of the project particularly as regards manufacturing costs and as regards the impact of this project on domestic manufacturing operations.

Research Department -- Please give us your comments on the project particularly as regards the state of Phillips' knowledge of the petrochemical processes shown. Please make recommendations concerning steps necessary to obtain definitive information on processes with which Phillips is not familiar. Please also provide information as to which processes require licenses and the availability and cost of such licenses.

Yours very truly,

M.W. Conn

M. W. Conn

FE-5
Attachment

PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

E 1416

September 20, 1963

Subject
Algerian Crude-Puerto Rican
Petrochemical Complex

Mr. Paul Parker
International Department
713-A P.B.

Dear Sir:

We have made a preliminary study of the practicality of an Algerian Crude Oil - European Refinery - Puerto Rican Petrochemical Complex. The project includes,

A. A 150,000 B/D crude reduction plant on the coast of Algeria to charge Hassi Messaoud crude oil. The plant would have simple processing facilities to split the crude oil into 50,000 B/D of gasoline, 93,000 B/D of reduced crude, and light ends for plant fuel. In addition there would be crude oil pipe line receiving storage, plus product storage and dock facilities for tanker movement of the two products. Also power, utility, and maintenance facilities required by the plant.

B. Three 31,000 B/D refineries in Europe to process the reduced crude into kerosine, diesel fuel, gas oil, and bunker C fuel oil. These plants would have facilities for receiving the tanker shipments of reduced crude charge and moving the four products to market.

C. A 50,000 B/D feed preparation and petrochemical producing complex in Puerto Rico. The feed preparation section would consist of hydrodesulfurization, catalytic reforming, solvent extraction, and fractionation. It would produce benzene, toluene, and xylenes to charge to the petrochemical units. It would also produce finished motor fuel for sale in the United States, naphtha for sale in Europe, and plant fuel.

   The petrochemical units would produce ammonia, urea, cyclohexanol-cyclohexanone, ortho and meta-xylene, polystyrene, and polyester.

We estimate a total investment cost for the three parts of $144,475,000 and a total capital requirement of $193,683,000. We estimate an AARR of 34% on an assumed 2/7 equity in the total capital requirement, and an AARR of 17% on the total capital required. These values are based on borrowing 5/7 of the total requirement, paying 6% interest on money used in Algeria and Europe, and 5% on that used in Puerto Rico, and repaying the loans in equal payments over the last eight years of a ten year life.

The construction period was considered to be two years with the entire investment requirement being paid out at the end of the first year. Operation was assumed at 50% of capacity the first year, 75% the second year, 90% the third year, and 100% in succeeding years.

The plant net-back prices and quantities used in these calculations are shown in the following tabulation.

Material	Plant Net Back Price		Production
Algeria			
Hassi Messaoud Crude Oil	-	$1.70/Bbl	150,000 B/D
Gasoline Puerto Rico	4.45¢/gal	$1.87/Bbl	50,000 B/D
Reduced Crude to Europe	-	-	93,000 B/D
Europe			
All distillate products assumed sold as Heating Gas Oil	10¢/gal	$4.22/Bbl	58,500 B/D
Bunker C Fuel Oil	-	$1.84/Bbl	30,000 B/D
Puerto Rico			
Motor Fuel	9.14¢/gal	$3.84/Bbl	23,055 B/D
Naphtha to Europe	5¢/gal	$2.10/Bbl	10,000 B/D
Benzene	19¢/gal	$7.98/Bbl	21.77 MM Gals/Yr
Ammonia	$55.00/T		140,890 Tons/Yr
Urea	$60.00/T		365,000 Tons/Yr
Cyclohexanol-Cyclohexanone	11¢/lb		200 MM Lbs/Yr
Polystyrene	16.9¢/lb		54.6 MM Lbs/Yr
Polyester	40¢/lb		72.2 MM Lb/Yr

Additional details of the several parts of this project are attached.

Yours very truly,

G. W. McCullough

DB:iw

E 1418

ATTACHMENTS TO LETTER

G. W. McCullough to Paul Parker
September 19, 1963

ALGERIAN CRUDE - PETROCHEMICAL COMPLEX

A. General Considerations

B. Plant Facilities
   1. Algeria
   2. Europe
   3. Puerto Rico
   4. Schematic Flow Sheets
      a. Overall
      b. Puerto Rico

C. Summary of Economics

D. Marketing Considerations for the Proposed Petrochemical Complex in Puerto Rico (C. W. Wolfe to L. H. Johnstone, 9-16-63)

E. Algerian Crude Supply (T. R. Wiggins to R. M. Waldby, 9-6-63)

F. Tanker Rates (W. A. Hartmann to R. M. Waldby, 8-30-63)

E 1419

GENERAL CONSIDERATIONS

By: Roy M. Waldby

On August 19. 1963, the Engineering Department was asked by the International Department to make a preliminary feasibility study of a large scale refining and petrochemical project. The following provides background information for the two cases included in the study.

The first case was based on the following premises:

1. The purchase of 300,000 barrels per day of "Hassi Messaoud type" crude.

2. Fractionate this crude in Algeria to produce 100,000 barrels per day of gasoline and approximately 200,000 barrels per day of "gasoline free" crude residue.

3. Ship the 100,000 barrels per day of gasoline to Puerto Rico. Catalytically reform the bulk of this gasoline and solvent extract the reformate to yield large volumes of benzene, toluene and xylenes. Convert the toluene and xylenes to petrochemicals or petrochemical intermediates. By shipping raffinate to Europe as charge stock for naphtha steam cracking, and by adjusting severity of catalytic reforming, yield not more than 49,000 barrels per day of by-product motor fuel for United States and Puerto Rico markets.

4. Ship the approximately 200,000 barrels per day of "gasoline free" crude residue to five identical simple refineries located throughout Europe. Refine approximately 40,000 barrels per day of this crude residue at each refinery to yield only middle distillates and "Bunker C" fuel oil.

5. Make a preliminary report on the feasibility study by September 6, 1963.

The project described above was chosen because of the following factors:

1. Phillips desires to secure a substantial import quota for refined products (to be marketed in Puerto Rico and the United States) through production of petrochemicals in Puerto Rico.

2. Phillips desires to find profitable means for utilizing petroleum products from the Sahara.

3. Phillips desires to enter the refining business in Europe on a substantial scale.

4. Preliminary studies of possible operations in Puerto Rico indicated that gasoline lends itself more readily to petrochemical manufacture than does crude oil. The studies also indicated that it is much more profitable to bring motor fuel alone into the United States under quota than to bring in refined products from full range crude oil.

5. Investigation of various crude oils available in large volume indicated that crude of the Hassi Messaoud type was best suited for this project because of low sulfur content, relatively low fuel oil content, substantial naphtha content of the gasoline fraction and low pour point of the distillate fraction.

The preliminary feasibility study of the "300,000 barrel per day" project was completed by September 6, 1963, with the help of many people. This study showed that, although the overall project appeared to have economic promise, total capital requirements were very high ($360,000,000), certain of the individual petrochemical plants were uneconomic, and marketing problems were formidable both for refined products and for petrochemicals.

Following discussions with Messrs. M. W. Conn, Paul J. Parker, R. W. Thomas and others, it was decided to study a second case involving purchase of 150,000 barrels per day of crude, the processing of 50,000 barrels per day of gasoline in Puerto Rico, and the refining of approximately 100,000 barrels per day of a "gasoline free" crude residue in three identical European refineries. Puerto Rican processing was still tailored to yield not more than 49% of by-product motor fuel but only the most profitable of the petrochemical plants studied in the original case were to be considered.

The results of this second study are discussed in later sections. The following points should be considered:

1. Singular advantages of this project:

   A. Purchase of crude in large volumes should result in a low cost per barrel.

   B. Gasoline, which is a distress product in Europe, is diverted to more favorable markets in the United States and Puerto Rico.

   C. Distillates, which command a premium price in Europe, are sold in European markets.

   D. Both investment for refining facilities and manufacturing costs are quite low on a per barrel basis because of the type of crude processed and because of the plan of operation.

   E. It appears that a United States corporation, whose business is 80% or more in Puerto Rico, can obtain a ten year holiday from all taxes on Puerto Rican petrochemical investments and profits and that such a corporation can declare dividends to a parent United States corporation subject only to a dividend tax of 7.8%.

2. Limitations of this study:

   A. No investment for marketing of refined products or petrochemicals has been considered.

   B. Prices used in these studies are "best judgment" figures and are open to considerable question until verified or disproved by marketing surveys.

C. None of the cost estimates made in connection with this study are of A.F.E. quality and some of the petrochemical plants are "best guesses" where information within the Company is not available.

3. Object of this study:

To cause consideration of the following question:

Does the overall plan appear to have sufficient merit to justify the expenditure of substantial money and manpower to verify or disprove the preliminary findings?

PLANT FACILITIES

ALGERIA

Processing Equipment

All processing facilities and product quantities were based on Phillips Crude Evaluation Report CEC-77-61 on Hassi Messaoud Composite Sample, and on a Cities Service analysis of Hassi Massaoud Crude dated September 1, 1960, Lake Charles, Louisiana. The Algerian plant consists of two parallel 75,000 BPD crude topping units. The crude oil is separated into a C_5 and lighter plant fuel, a C_5 to 320°F EP gasoline, and a 320°F IBP reduced crude in a single tower. Because of an expected water shortage and the low temperature required, the fractionator was reboiled instead of the more typical steam stripping. No crude desalting was provided because of the low salt content and the low temperature used. The major equipment was sized and cost estimated.

Storage

Three days storage for incoming crude oil was provided. It was assumed that the plant operators would have enough control of the pipeline that this would be sufficient. Twelve days storage for both products was provided. All movement from the plant was considered to be by large sized tankers and docks were provided for this purpose.

Auxiliaries

The plant site was assumed to be fairly isolated. A power plant, and more than normal warehouse, warehouse stocks, supplies, and maintenance equipment were provided. The office and laboratory were relatively simple. No personnel housing or community facilities were included. Miscellaneous plant facilities and yard lines were estimated from the plant needs.

Operating Costs

Plant operating costs were estimated at 10¢/Bbl of charge based on domestic plant operating costs. To this was added 1¢/Bbl for management, technical assistance, and local taxes and insurance. Land rental was assumed to be $1,200/acre/year for 200 acres.

Estimated Investment

The estimated Algerian investment requirement is tabulated below.

Item	Cost
2 - 75,000 B/D Topping Units	$4,100,000
Storage, 2,250,000 Bbls @ $1.00/Bbl	2,250,000
Office, Warehouse, Laboratory	600,000
Warehouse Stocks, Supplies, Maintenance Equipment	600,000
Docks	1,350,000
Power Plant	300,000
Miscellaneous and Yard Lines	2,000,000
Total	$11,200,000

Working Capital

Working capital requirements were based on estimated plant inventory and accounts receivable as shown in the following tabulation.

Inventory		
Crude Oil	300,000 Bbls @ $1.70	$ 510,000
Reduced Crude	1,200,000 Bbls @ 1.92	2,304,000
Gasoline	600,000 Bbls @ 1.87	1,122,000
Total Inventory		$3,936,000
Accounts Receivable		
45 days @ full rate		
Reduced Crude	93,000 x 45 x $1.92	$8,035,000
Naphtha	50,000 x 45 x 1.87	4,208,000
Total Accounts Receivable		$12,243,000
Cash on Hand		$1,000,000
Total Working Capital		$17,179,000

Income Tax

Income tax was assumed to be 50% on taxable income. Six per cent interest on the unpaid balance of a loan amounting to 5/7 of the total capital requirement was considered as an expense. The loan was repaid in eight equal installments over the last eight years of an assumed ten year operating life. Salvage value was assumed to be zero. Working capital was assumed fully recovered.

Processing Equipment

Three 31,000 B/D simple refineries are provided at sea ports in Europe. The exact locations were not chosen. The reduced crude is separated into kerosine, diesel fuel, gas oil, and fuel oil. A single tower fractionator with necessary steam strippers and driers is provided. Reduced crude electrical desalting is provided to remove sea water from the tanker trip, and because of the higher temperature levels compared to the Algerian operation. No product treating is required. The major equipment was sized and cost estimated.

Storage

Approximately 20 days storage was provided at each plant for incoming reduced crude charge. About 36 days storage was provided for finished products. Movement from the plant was considered to be by truck, rail, barge, and tanker. Docks were provided.

Auxiliaries

The plant sites were considered to be in developed locations. Purchased power was assumed. Warehouse, warehouse stocks, supplies, and maintenance equipment were similar to United States practice. The office and laboratory were fairly simple. No personnel or community facilities were included. Miscellaneous plant facilities and yard lines were estimated from the plant needs.

Operating Costs

Plant operating costs were estimated at 15¢/Bbl. of charge based on domestic plant operating costs. To this was added 2¢/Bbl. for management, technical assistance, and local taxes and insurance. Land rental was assumed to be $1,200/acre/year for 200 acres for each refinery.

Estimated Investment

The estimated investment required for each European refinery is tabulated below.

Item	Cost
1-31,000 B/D Crude Unut	$1,933,000
Storage, 1,800,000 Bbls @ $1.00/Bbl.	1,800,000
Office, Warehouse, Laboratory	400,000
Warehouse Stocks, Supplies, Maintenance Equipment	600,000
Docks	1,000,000
Miscellaneous and Yard Lines	2,000,000
Total	$7,733,000
Three Refineries	$23,200,000

Working Capital

Working capital requirements were based on estimated plant inventory and accounts receivable for the three refineries as shown in the following tabulation.

Inventory	
Reduced Crude 1,000,000 Bbls. @ $2.19	$2,190,000
Products 1,500,000 Bbls. @ $2.48	3,720,000
Total Inventory	$5,910,000
Accounts Receivable	
45 days at full rate	
Distillate 58,500 x 45 x $4.22	$11,110,000
Fuel Oil 30,000 x 45 x $1.84	2,486,000
Total Accounts Receivable	$13,596,000
Cash on Hand	$ 3,000,000
Total Working Capital in Europe	$22,506,000
Less Accounts Receivable on Reduced Crude	$ 8,035,000
Working Capital in Algeria	$17,179,000
Total Working Capital, Algeria and Europe	$31,650,000
Less Funds Generated by Project	$ 6,800,000
Total Required	$24,850,000

Income Tax

Income tax was assumed to be 50% on taxable income. Six percent interest on the unpaid balance of a loan amounting to 5/7 of the total capital requirement was considered as an expense. The loan was repaid in eight equal installments over the last eight years of an assumed ten year operating life. Salvage value was assumed to be zero. Working capital was assumed fully recovered.

PUERTO RICO

FEED PREPARATION

E 1426

Processing Equipment

The feed preparation division in Puerto Rico has two primary objectives, (1) Prepare benzene, toluene, and xylene as feed stocks for further processing, and (2) Produce a high quality motor fuel for sale. The entire charge is first sent to a hydrodesulfurization unit to reduce sulfur to a low level. The desulfurized gasoline is then fractionated into three main streams. A low end point naphtha amounting to 16% of the charge is prepared for sale in Europe, and for motor fuel blending. A C_6-C_9 fraction amounting to 58% of the charge is catalytically reformed for benzene, toluene, xylene production, and the remaining heavier fraction amounting to 28% of the charge is catalytically reformed to increase the octane number to motor fuel quality. The B-T-X reformate is solvent extracted to supply high purity benzene, toluene, and xylene, and the raffinate is further reformed to increase the octane number to motor fuel quality.

The seven units required for these services were sized and their costs ratioed from operating Phillips' units.

Storage

Approximately two weeks storage for incoming plant charge, and four weeks storage for intermediate and finished product storage was provided. All movement into and from the plant would be by tanker or freighter.

Auxiliaries

The plant site was assumed to be in a semi-developed location. Purchased power was assumed. Warehouse, warehouse stocks, supplies and maintenance equipment were similar to United States practice. The office and laboratory would be fairly sophisticated to handle the complex operation. No personnel or community facilities were included.

Operating Costs

Plant operating costs were estimated at 31¢/Bbl. of charge based on domestic plant operating costs. To this was added 4¢/Bbl. for management, technical assistance, and insurance. It was assumed there would be no local taxes. Land rental was assumed to be $500/acre/year for 300 acres.

Estimated Investment

The estimated Puerto Rican investment for feed preparation facilities is tabulated below.

Item	Cost
Processing	
HDS - 2-27,000 B/D	$3,400,000
Hvy. St. Run Reform - 1-16,000 B/D	3,200,000
BTX Reform - 1-30,500 B/D	4,650,000
Raffinate Reform - 1-15,000 B/D	3,200,000
Udex - 2-12,000 B/D	5,850,000
Total Process	$20,300,000

E 1427

Item	Cost
Off Plot	
Steam Plant	$2,300,000
Cooling	900,000
Tank and Pump House	2,500,000
Office, Lab, Roads, Piping, Etc.	7,500,000
Total Off Plot	13,200,000
Total Feed Preparation	$33,500,000

Operating Economics

The operating economics of the feed preparation and Petrochemical Processing were considered as a unit.

FF:7

PETROCHEMICAL COMPLEX

E 1428

Processing Equipment

C_8 Separation

Mixed-Xylene feedstock (3,785 B/D) from the refining operations is separated by superfractionation and fractional crystalization. Products are 555 B/D ethyl benzene (feed for polystyrene plant), 440 B/D para-xylene (feed for polyester plant), and 2,790 B/D of ortho and meta-xylene (blended into motor fuel).

Polystyrene

Ethylbenzene feedstock (555 B/D) is catalytically dehydrogenated to styrene monomer, which is batch polymerized to polystyrene. Economics are based on information from Petrofina. Product is 54.6 MM Lb/Yr of crystal, medium-impact and high-impact polystyrene resins.

Polyester

Para-Xylene feedstock (440 B/D) is oxidized using nitric acid, esterified with methanol and sulfuric acid, and reacted with ethylene glycol to obtain dimethyl terephthalate ester monomer, which is polymerized to obtain polyester. Economics are based on very rough cost estimates for the DuPont process. Product is 72.2 MM Lb/Yr of polyester resin.

Dealkylation-Hydrogenation

Toluene feedstock (3,150 B/D) from the refining operation is hydro-dealkylated to produce benzene, which is hydrogenated with hydrogen from the refining operation to obtain cyclohexane. Products are benzene (120 B/D) and cyclohexane (2,800 B/D).

Cyclohexanol-Cyclohexanone

Cyclohexane feedstock (2,800 B/D) is catalytically oxygenated to a mixture of cyclohexanol-cyclohexanone. Economics are based on cost estimates developed by R & D for the "Inventa" process which is licensed by Catalytic Construction. Product is 200 MM Lb/Yr of cyclohexanone-cyclohexanol.

Ammonia

Hydrogen obtained from the refining operations (12 MM SCFD) and hydrogen obtained by reforming 3,560 B/D naphtha are feedstock to produce 1,000 T/D of ammonia.

Urea

Ammonia (590 T/D) and CO_2 from the naphtha reforming are feedstock to produce 1,000 T/D urea.

Nitric Acid

Ammonia (24 T/D) and recycle nitrogen oxides are oxidized over catalyst to nitric acid (164 T/D) for use in the polyester plant. Nitrogen oxides are recycled from the polyester plant back to the acid plant.

Operating Costs

Operating costs for the petrochemical operations were estimated from a variety of sources, depending on the information available on the desired processing steps. In no case were detailed design or cost studies possible in the time available. Costs for the dealkylation, hydrogenation, xylene separation, and nitric acid units were based on Phillips estimates from previous studies, ratioed to the desired size. Costs for the ammonia, urea, styrene-polystyrene, and cyclohexanol-cyclohexanone units were based on information obtained previously from outside sources. Some of this information is reasonably complete and some would require much more detailed investigation with process suppliers. Costs for the polyester unit are very rough estimates based on Phillips processes judged to be of similar complexity.

Costs for the various operations are shown in the following tabulation.

PUERTO RICO PETROCHEMICAL COMPLEX OPERATING COSTS

Feedstock	$1,000/Year
St. Run Gasoline	$40,150
Operating Costs - (Includes Depreciation)	
Refining	9,737
Ammonia	7,917
Urea	4,203
Nitric Acid	468
Hydro-Dealkylation	2,308
Cyclohexanone-ol	4,366
C_8 Separation	2,057
Polystyrene	3,901
Polyester	8,520
Ex-Feedstock	$43,477
Total	$83,627

Estimated Investment

The estimated investment for the several petrochemical units was based on the same variety of sources discussed above for the operating costs. Many of these units must be studied in much more detail to obtain costs of a quality suitable as the basis for investment decisions.

The estimated investment requirements are shown in the following tabulation.

PUERTO RICO PETROCHEMICAL COMPLEX
PLANT INVESTMENT (BATTERY LIMITS & OFF-PLOT)*

Refining Area	$33,500,000
Ammonia Plant	18,400,000
Urea Plant	7,800,000
Nitric Acid Plant	1,600,000
Hydrodealkyl Plant	6,650,000
Cyclohexanone-ol Plant	13,500,000
C_8 Separation Plant	5,535,000
Polystyrene Plant	9,590,000
Polyester Plant	13,500,000
Total Plant Investment	$110,075,000

*Off-Plot assumed 35% of Battery Limits Investment for Petrochemical Units.

Working Capital

Working capital for the entire Puerto Rico complex (feed preparation and petrochemicals) was based on the estimated inventory of feedstock, in-process, and finished products and on 45 days accounts receivable on products sold. At full capacity this amount is:

Feedstock	$ 1,540,000
In-Process and Finished Inventory	11,174,000
Accounts Receivable	14,388,000
Total	$27,102,000

Income Tax

It was assumed there would be a ten year holiday on all taxes in Puerto Rico for the operating company. Dividends paid to Phillips were taxed at 7.8%.

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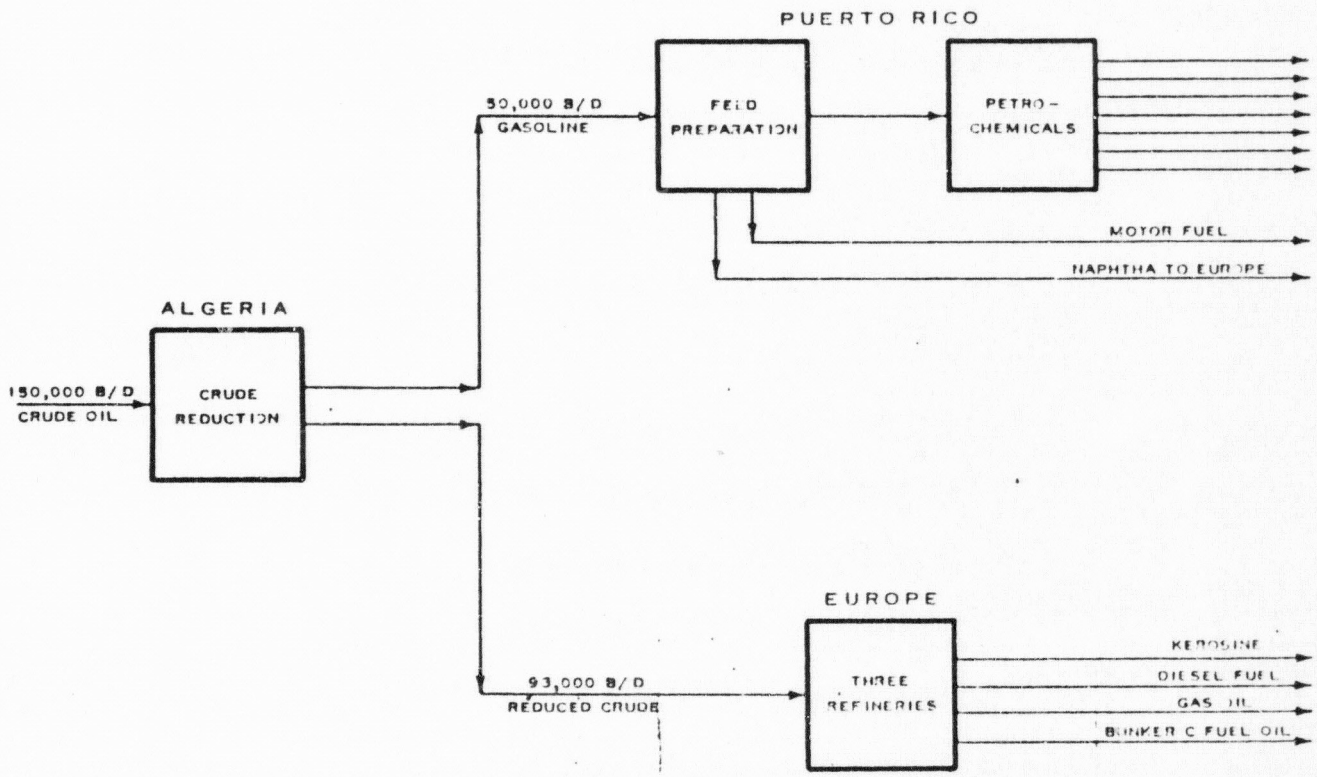
ALGERIAN CRUDE – PUERTO RICAN PETROCHEMICAL PROJECT



E 1431

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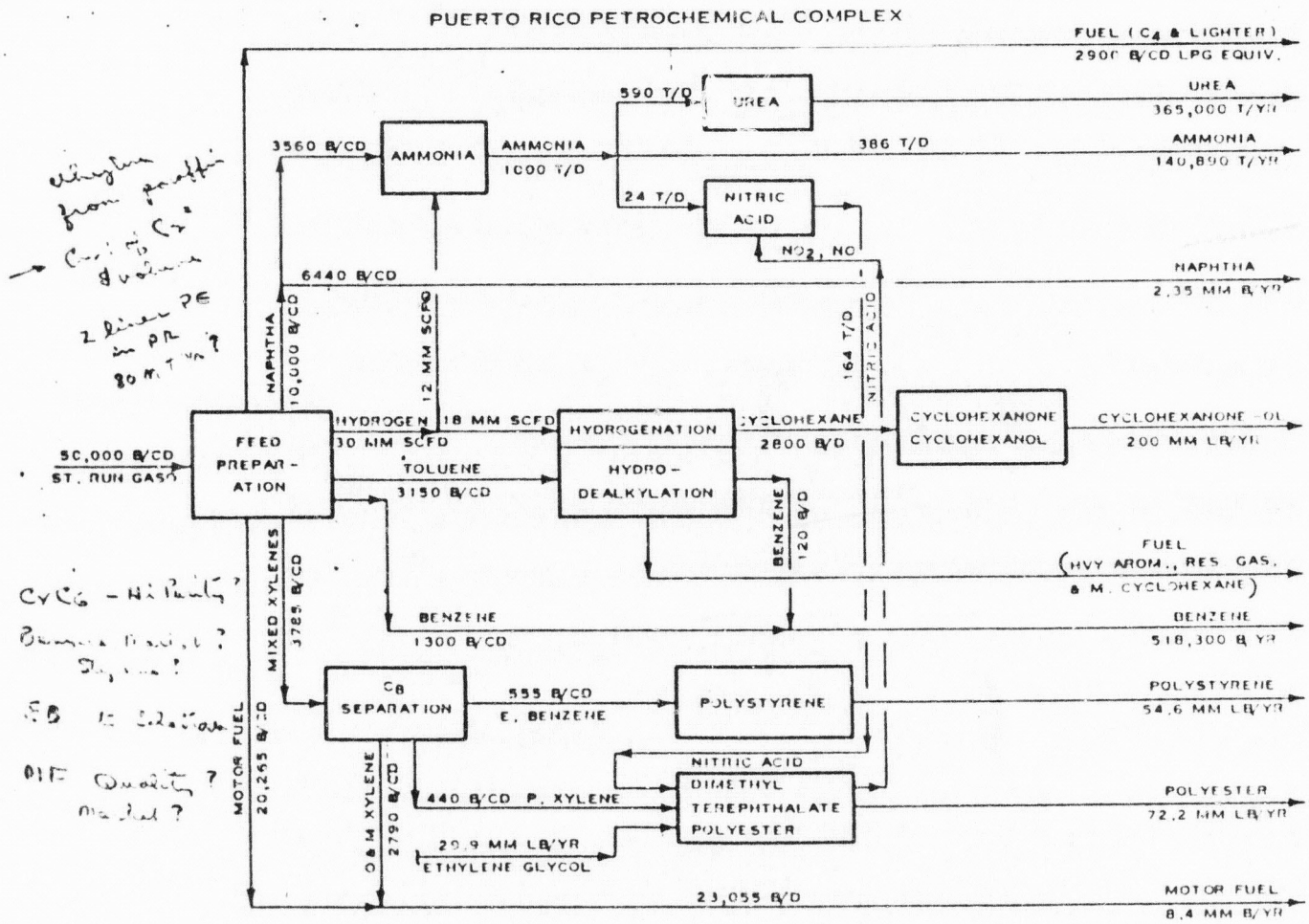
PUERTO RICO PETROCHEMICAL COMPLEX
FUEL (C_4 & LIGHTER)
2900 B/CD LPG EQUIV.
590 T/D
UREA
UREA
365,000 T/YR
3560 B/CD
AMMONIA
AMMONIA
1000 T/D
386 T/D
AMMONIA
140,890 T/YR
24 T/D
NITRIC ACID
NO_2, NO
6440 B/CD
NAPHTHA
2.35 MM B/YR
NAPHTHA
10,000 B/CD
12 MM SCFD
164 T/D
NITRIC ACID
50,000 B/CD
ST. RUN GAS
FEED PREPAR-ATION
HYDROGEN
30 MM SCFD
18 MM SCFD
HYDROGENATION
HYDRO-DEALKYLATION
CYCLOHEXANE
2800 B/D
CYCLOHEXANONE
CYCLOHEXANOL
CYCLOHEXANONE + OL
200 MM LB/YR
TOLUENE
3150 B/CD
BENZENE
120 B/D
FUEL
(HVY AROM., RES GAS,
& M. CYCLOHEXANE)
MIXED XYLENES
3785 B/CD
BENZENE
1300 B/CD
BENZENE
518,300 B/YR
MOTOR FUEL
20,265 B/CD
C_8 SEPARATION
555 B/CD
E. BENZENE
POLYSTYRENE
POLYSTYRENE
54.6 MM LB/YR
NITRIC ACID
440 B/CD P. XYLENE
DIMETHYL TEREPHTHALATE POLYESTER
POLYESTER
72.2 MM LB/YR
O & M XYLENE
2790 B/CD
29.9 MM LB/YR
ETHYLENE GLYCOL
23,055 B/D
MOTOR FUEL
8.4 MM B/YR

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SUMMARY OF ECONOMICS OF
PROPOSED REFINERIES IN ALGERIA, EUROPE & PUERTO RICO
AND PETROCHEMICAL PLANT IN PUERTO RICO
(1000s)

	Algeria & Europe	Puerto Rico	Combination
RESULTS TO CORPORATION			
Income - 10 years operation	$ 1,321,873	$ 1,066,030	$ 2,387,903
Less Expenses:			
Operating Expenses	974,719	640,539	1,615,258
Interest	17,082	31,380	48,462
Income Tax (50% rate in Europe & Algeria only)	147,439	--	147,439
Total	$ 1,139,240	$ 671,919	$ 1,811,159
Operating Income after Tax	182,633	394,111	576,744
Recovery of Working Capital - end 10 yrs. oper.	31,650	27,102	58,752
Total Income	214,283	421,213	635,496
Investment and Working Capital			
Equity	$ 16,256	$ 37,074	$ 53,330
Borrowed	43,794	96,559	140,353
Funds Generated by Project	6,800	7,194	13,994
Total	$ 66,850	$ 140,827	$ 207,677
Net Profit	$ 147,433	$ 280,386	$ 427,819
Years Payout from Startup (Add 2 yrs. for construction)	4.3	4.4	4.4
Number of Times Investment Returned	3.2	3.0	3.1
Annual Rate of Return on Total Capital	23%	20%	21%
RESULTS TO PHILLIPS EQUITY CAPITAL			
Dividends from corporation	$ 163,689	$ 317,460	$ 481,149
Less Dividends Tax @ 7.8% (Puerto Rico only)	--	21,871	21,871
Dividends after Tax	$ 163,689	$ 295,589	$ 459,278
Investment (Equity Capital)	16,256	37,074	53,330
Net Profit	$ 147,433	$ 258,515	$ 405,948
Years Payout from Startup (Add 2 yrs. for construction)	2.1	3.1	2.7
Number of Times Investment Returned	10.1	8.0	8.6
Annual Rate of Return on Equity Capital	39%	31%	34%
RESULTS TO PHILLIPS TOTAL CAPITAL			
Net Profit	$147,433	$ 258,515	$ 405,948
Years Payout from Startup (Add 2 yrs. for construction)	4.9	6.1	5.7
Number of Times Investment Returned	3.2	2.8	3.0
Annual Rate of Return on Total Capital	21%	16%	17%

cc: R. W. Thomas (r) P. M. Arnold
P. J. Parker
T. L. Cubbage (r) A. J. Head
C. A. Buell
R. W. Waldby

A. E. Buell (r) R. M. Leader
R. K. Sims
R. J. Goertz

E 1434

INTER-OFFICE CORRESPONDENCE / SUBJECT
BARTLESVILLE, OKLAHOMA

Marketing Considerations for the Proposed Petrochemical Complex in Puerto Rico
CWW-23-63CD

September 16, 1963

Mr. L. H. Johnstone
764 Adams Building

This will supplement CWW-21-63CD concerning the marketing aspects of the proposed aromatics-based petrochemical complex for Puerto Rico. We are still assuming that some 50,000 barrels a day of feedstock, essentially naphthenic in character, is to be consumed in the project. The domestic market for benzene and cyclohexane would be severely depressed with the addition of 115 million gallons a year of benzene and benzene-derivatives in 1966. We are now suggesting a "product mix" that is representative of what might be moved into both domestic and foreign markets in 1966 at the indicated price levels. This production and marketing outline differs considerably from that originally proposed and, of course, must be critically examined from both marketing and technical standpoints before serious evaluation can be given to the project.

This preliminary examination indicates that from a marketing standpoint the following product spectrum merits consideration---cyclohexanone-cyclohexanol mixture to be sold as a precursor for nylon 66, cyclohexanone as a precursor for nylon 6, synthetic phenol, para-xylene and/or terephthalic acid, phthalic anhydride derived from ortho-xylene, styrene or polystyrene, detergent alkylate based on linear paraffins, methanol and/or formaldehyde, and ammonia with derivatives such as urea, ammonium nitrate and ammonium sulfate. Excess benzene and cyclohexane should be valued at $0.19 a gallon, f.o.b. Puerto Rico.

It should be emphasized that we do not have sufficient information at hand to evaluate with any degree of certainty the international marketing picture for most of these products. Accordingly, the world demand and capacity situation must be considered as being conjectural in practically all cases. Some general consideration should be emphasized. In the U. S. petrochemical picture the trend for the past several years has been and will continue to be one of vertical integration with chemical companies moving backwards into a basic position in intermediates and raw materials, and with petroleum companies moving forward from their raw materials bases through intermediates into finished chemical products and in many cases fabricated items. In brief, we have witnessed and are witnessing the gradual demise of the merchant supplier of chemical intermediates. This same trend is starting and will undoubtedly continue in the Common Market. Accordingly, evaluation in depth of the proposed Puerto Rican complex should consider these basic trends and allow for the possibility that by 1970 the complex would be forced to move forward in the integration chain, producing or supplying captive producers products based on the key aromatic building blocks that will be flowing from the complex.

Published information pertaining to the European market for aromatics and aromatic derivatives indicates an oversupply picture will develop in the 1966-1968 period. Petrochemical processing in the aromatics field in Europe has been expanding rapidly since 1960. The current picture in Europe is far from homogeneous, with aromatics still in short supply

in Italy and Great Britain but in oversupply in West Germany and France. The picture evidently varies from month to month with resultant changes in tariff considerations and anti-dumping laws.

The world-wide fertilizer picture is in a state of flux. The demand for nitrogenous material when viewed from a soil condition standpoint is probably far greater than that which can be supplied from current and projected capacities. However, the economic facts of life dictate that far less than optimum fertilization rate occurs in the majority of the world's food producing areas. The fertilizer section of this report is perhaps the most speculative from a market knowledge standpoint.

In summary, then, on a general basis a critical review of world markets for all of these products is an absolute necessity before thorough evaluation of the project can be made. Such a study would involve field work both in and out of the United States and intensive effort by two or three men for at least three months.

The following sections represent a "thumbnail sketch" of the anticipated marketing situation in the various product areas:

CYCLOHEXANOL AND CYCLOHEXANONE

It is possible that the upgrading of cyclohexane to a cyclohexanol-cyclohexanone mixture through air oxidation would yield a product that would be attractive to the producers of nylon 66. Consideration has been given such a marketing scheme by Phillips and others over the last ten years. The flexibility of such an operation would enable us to also supply cyclohexanone as a relatively pure product to those producers of caprolactam who utilize the hydroxylamine approach. We suggest that a plant be considered capable of producing 200 million pounds a year of the mixture at a selling price of $0.11 a pound, f.o.b. Puerto Rico. In addition, we suggest that 50 million pounds of cyclohexanone be produced for a selling price based on the mixture but including the additional processing costs involved in converting cyclohexanol to cyclohexanone.

Production of this much material would probably consume about 50 million gallons a year of cyclohexane. This amounts to almost 38 percent of anticipated U. S. demand in 1966 or 10 percent of total world demand for cyclohexane in 1966. Availability of the mixture at the indicated price level would still seriously affect Phillips' domestic cyclohexane sales. Nevertheless, such an operation could perhaps lead to the capture of new business, particularly in the export field.

DETERGENT ALKYLATE

We suggest that consideration be given to a 250 million pounds a year linear detergent alkylate plant. The supply-demand picture for conventional alkylate is outlined below. It is almost certain that linear alkylate will replace conventional alkylate in the U. S. at prices levels equivalent to those current and projected for conventional material.

MILLION POUNDS

Demand 1966		Capacity 1963	
U. S.	Free World Total	U. S.	Free World Total
475	1, 160	600	1, 500

Current U. S. Price $0.0975/Lb., frt. eq. (conventional alkylate)

Use in Study $0.075/Lb., f.o.b. Puerto Rico (linear alkylate)

PHENOL

As a benzene-consuming operation we suggest a phenol production unit be considered. Any of the commercial processes based on benzene with the exception of the cumene route would probably be acceptable. Plant size should probably be about 180 million pounds.

MILLION POUNDS

Demand 1966		Capacity 1963	
U. S.	Free World Total	U. S.	Free World Total
1,050	n.a.	1,136	2,609

Current U. S. Price $0.1125/Lb., frt. eq.

Use in Study $0.08/Lb., f.o.b. Puerto Rico

n.a. - Not available.

STYRENE OR POLYSTYRENE

The amount of natural ethyl benzene available evidently dictates a styrene plant sized at about 85 million pounds a year. We suggest that a price of $0.07 a pound, f.o.b. Puerto Rico, be used for styrene. If converted to polystyrene, we suggest a reasonable product balance between general purpose and impact grades of polystyrene, with prices of $0.13 a pound for general purpose and a range of $0.16-$0.22 a pound for impact grades being utilized. Available information on the market situation is outlined below:

MILLION POUNDS

	Demand 1966		Capacity 1963	
	U. S.	Free World Total	U. S.	Free World Total
Styrene	2,340	n.a.	2,379	n.a.
Polystyrene	1,278	1,850	1,300+	n.a.

n.a. - Not available.

PARA-XYLENE OR TEREPHTHALIC ACID

Evidently, 85 million pounds a year of para-xylene or 70 million pounds a year of terephthalic acid represents the amounts that can be made available from the feedstock. We suggest that prices of $0.075 and $0.20, respectively be used for the f.o.b. Puerto Rico values on these products. Market information is outlined below:

MILLION POUNDS

	Demand 1966		Capacity 1963	
	U. S.	Free World Total	U. S.	Free World Total
Para-xylene	355	955	366	798
Terephthalic Acid	285*	760*	287*	858*

*Represents DMT, since terephthalic acid per se is not yet used commercially.

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PHTHALIC ANHYDRIDE

Ortho-xylene availability indicates a capability of producing 130 million pounds a year of phthalic anhydride. The phthalic market is in very bad shape domestically with no reasonable chance for improvement. We suggest this amount of material could be marketed at $0.06 a pound. Phthalic dropped to $0.085 a pound, representing a very unattractive level for producers, but has recently returned to the $0.115 level.

MILLION POUNDS

Demand 1966		Capacity 1963	
U. S.	Free World Total	U. S.	Free World Total
445	n.a.	650	n.a.

n.a. - Not available.

METHANOL

We suggest that methanol be considered primarily because it is a large-volume chemical that could be co-produced in an ammonia facility. A 40 million gallon plant would be comparatively sized with the majority of the U. S. plants with the exception of Du Pont's huge facility sized at over 100 million gallons. Formaldehyde should be considered on a deeper analysis.

MILLION GALLONS

Demand 1966		Capacity 1963	
U. S.	Free World Total	U. S.	Free World Total
370	811	443	1,000

Suggested Price $0.16/Gal., f.o.b. Puerto Rico

NITROGENOUS FERTILIZER

We do not have reliable data on world capacity and consumption for the various nitrogenous fertilizers. Consensus of the overall supply-demand situation as reported in the literature in terms of nitrogen is presented below:

MILLION METRIC TONS

Demand 1966		Capacity 1963	
U. S.	Free World Total	U. S.	Free World Total
-	20	-	16-17*

*Capacity in 1966 expected to be 27-30.

We suggest that plant sizing for ammonia and any of the common derivatives, i.e., ammonium nitrate, ammonium sulfate, and urea, be based on feedstock availability and extended analysis of world-wide marketing conditions. Prices that must be used if these

E 1438

products are to be marketed on a world basis would have to be very low. Suggested ranges are:

Ammonia	$50-$55 a ton, f.o.b. Puerto Rico
Urea	$55-$60 a ton, f.o.b. Puerto Rico
Ammonium Sulfate	$22-$23 a ton, f.o.b. Puerto Rico

This report is intended to serve only as a guide in screening possible products for an operation of the magnitude envisioned. Detailed marketing research on an international basis will be required to realistically evaluate the feasibility of such a venture.

C. W. Wolfe

C. W. Wolfe

CWW:vr

E 1439

PHILLIPS 66

September 6, 1963

INTER-OFFICE CORRESPONDENCE / SUBJECT
BARTLESVILLE, OKLAHOMA

Algerian Project
Crude Supply
TRW-29-63

Mr. R. M. Waldby
International Department

All of the major oil fields now known in Algeria would be available to the proposed 24" "Trapal" crude line. The characteristics of the Hassi Messaoud crude are fairly representative of the composite of all of the Algerian crudes except that from the composite, the 400° F. EP straight run yield may be somewhat lower and the pour point on the distillates may be higher. It would be necessary to obtain complete up-to-date analyses of all of the fields to firm up on the characteristics and yields for a composite.

The following lists the known major oil fields and their 1962 daily production:

	B/D	°API
Zarzaitine	153,600	43
Edjeleh	39,000	34
Tiguentourine	6,800	43
El Adeb Larache	6,300	42
Ohanet South	3,900	39
Ohanet North	11,200	39
Hassi Messaoud	197,700	43
El Gassi - El Agreb	16,300	45
	434,800	

We have up-to-date complete analysis on the Hassi Messaoud crude only. We also have limited analysis of the Zarzaitine and Edjeleh crudes. These three crudes represent 90% of the 1962 production. The following are brief comparisons of these three crudes and includes the Gassi Touil field:

E 1440

INTER-OFFICE CORRESPONDENCE / SUBJECT
BARTLESVILLE, OKLAHOMA

1-Har-15-63MT

August 30, 1963

MEMORANDUM

Recd Acct. ... 3:40 PM
Office Of C. J. Watson

To: R. M. Waldby

From: W. A. Hartmann

This should satisfy your recent request for various ocean transportation costs on crude and refined products.

Tabulated below is our best estimate of these costs based on today's tanker and money market. We have assumed: (1) company ownership, borrowing at 6% and amortizing over 20 years, (2) five - ten year time charter at $1.95/DWT, (3) Inta scale published rate less 50%.

	Volume/year	Company Owned	Time Charter	Inta Scale
Bougie to Hamburg	73,000,000 bbls.	13.8¢/bbl.	17.2¢/bbl.	19.2¢/bbl.
Bougie to Puerto Rico	36,500,000 bbls.	18.8¢/bbl.	22.6¢/bbl.	27.0¢/bbl.(est.)
Bougie to N. Europe (3 ports)	73,000,000 bbls.	15.3¢/bbl.	19.9¢/bbl.	19.2¢/bbl.
Puerto Rico to New York	18,250,000 bbls.	8.3¢/bbl.	9.8¢/bbl.	11.0¢/bbl.(est.)
Kharg Island to Hamburg	14,600,000 bbls.	39.0¢/bbl.	47.0¢/bbl.	47.7¢/bbl.

Investment

Bougie to Hamburg	6	64,000 DWT ships	$40,320,000
Bougie to Puerto Rico	5	54,000 DWT ships	28,350,000
Bougie to N. Europe (3 ports)	8	58,000 DWT ships	48,720,000
Puerto Rico to New York	1	58,000 DWT ships	6,090,000
Kharg Island to Hamburg	4	55,000 DWT ships	23,100,000

The above investments assume Japanese construction at $105 per dead weight ton.

If you need additional information, please call.

cc: Mr. C. H. Trotter

September 6, 1963

Mr. R. M. Waldby

Crude	Hassi Messaoud	Zarzaitine	Edjelen
°API	44.0	41.2	34.2
% S	0.17	0.055	0.098
Pour	<-50	+25	+25

	Vol. % Of Crude	Pour		Vol. % Of Crude	Pour		Vol. % Of Crude	Pour
				1.4			0.1	
C_4 & Ltr.	4.4			33.5			23.2	
C_5 - 400	42.4			12.4	<-20		11.1	-20
400 - 500	15.0	-43 F.P.	500-700	28.3	+55	500-700	25.6	+20
500 - 650	15.0	+15	700-1120	21.3	+115	700-1120	34.4	+50
650 - 1150	21.4	+90	1120+	3.1		1120+	5.6	
1150+	1.8							

Crude	Gassi Touil #3
°API	45.8
% S	<0.03
Pour	+ 5

	Vol.% Of Crude	Pour
C_4 & Ltr.	1.1	
C_5 - 400	33.8	
400 - 500	17.9	-39 F.P.
500 - 650	20.3	+30
650 - 1050	22.9	+100
150+	4.0	

As the project progresses, we will be available to assist in acquiring the detailed analysis and information concerning the presently known crude oils or any new oil fields which may develop.

We will be happy to discuss this further with you as required.

T. R. Wiggins

TRW:jr

cc: H. B. Hettinger (r) S. D. Lawson

USA 33a - 476
(ED 4-23-71)

E 1442

EXHIBIT
U. S. DIST. COURT
S. D. OF N. Y.

223

PLAINTIFF'S EXHIBIT 436
11/27/72

245 Pages

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No. (15) 14

E 1443

PLF'S EX # 236

11-27-72 DMP

REQUEST FOR OIL IMPORT ALLOCATION

PUERTO RICO OIL & PETROCHEMICAL COMPANY

San Juan, P.R. - New York, N.Y.

June, 1963

E 1444

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REPORT IN BRIEF

E 1445

The purpose of this report is to outline the project for a petrochemical core industry as an essential part of the economic development of Puerto Rico, and to request an oil import allocation to establish this new industry.

NEED FOR A PETROCHEMICAL INDUSTRY

The economy of Puerto Rico will benefit by the establishment of a company whose express purpose is the development of a petrochemical industry.

Recent industrial development on the Island has resulted in the employment of primarily female labor. It is now urgent that new industry be directed towards the employment of male labor.

This industry will be the means by which a critically depressed area will be transformed into a strong, economic community.

A petrochemical industry will provide a major construction program; a major area development; an immediate petrochemical feed plant; and future petrochemical plants. This program is all based on continuing growth in this area of construction, operation, and new development in a continuing growth cycle, including support industries.

A petrochemical industry will compensate for the lack of indigenous raw materials on the island and will revive interest by U.S. chemical companies in establishing subsidiaries in Puerto Rico.

(See Chapter I)

CORE PLANT REQUIRED

The growth of a petrochemical industry depends upon a core plant to supply petrochemicals and chemical feed stocks. These products will compensate for the lack of natural resources and will provide raw materials for a petrochemical industry.

From a practical standpoint and in order to be economic, the plant must also recover and market the residual petroleum products which will be quite substantial, particularly in the early stages of operation, while additional petrochemical outlets are being developed.

The core plant is not to be a static specific refinery or petrochemical plant, but a flexible petrochemical raw material feed plant which will continue to supply additional petrochemical raw materials as they can be used.

The establishment of a core plant of this type is therefore the essential first step in the establishment of a growing petrochemical industry in Puerto Rico.

(See Chapter II)

ACTION BY COMMONWEALTH OF PUERTO RICO

To implement the establishment of this project, the Commonwealth of Puerto Rico has agreed to clear and provide land, housing facilities,

necessary building permits, assistance for support industries, port installation at Mayaguez, and other necessary related facilities.

The Commonwealth has stated that this project is of the highest economic priority, should proceed with utmost dispatch, and has their full support.

(See Chapter III)

COMMERCIAL IMPLEMENTATION

The purpose of the Puerto Rican Oil and Petrochemical Company is stated in the first paragraph of its charter, as follows:

> "The company is formed for the express purpose of developing a chemical and petrochemical industry in Puerto Rico. It will design and build a refinery to produce, initially, sulfur, aromatic petrochemicals and petroleum products. This refinery will be the basis of and feed plant for the petrochemical industry as it grows. The refinery will be designed so that petrochemical side streams can be withdrawn in the future. When these side streams are needed, the company will install the necessary additional facilities to purify them. The company will also promote additional chemical and petrochemical projects related to the development of the petrochemical industry."

Arrangements have been made with Phillips Petroleum Company to supply crude oil and to market the petrochemical and related petroleum products.

Sulfur will be marketed by PROPCO.

Monsanto Chemical Company has identified its interest in a chemical feed stock of high wax content.

Other petrochemical companies have expressed their interest in feed stocks for different petrochemical end products. These will be pursued and developed as soon as an oil import allocation is authorized.

A fueling station is planned for ships passing through the Mona Passage. This will be available to supply both commercial and military vessels.

In addition to providing a core industry necessary for the basic economic growth and development of Puerto Rico, the proposed company will place many American companies who wish to participate in a strong position to compete for world business.

PROPCO also proposes to build a satellite plant adjacent to the core plant to produce lead antiknock additives.

PROPCO dollar sales volume is expected to be 53% petrochemical and "non-quota" petrochemical fuels initially. As satellite petrochemical plants are built, the ratio of petrochemical sales will, of course, increase.

(See Chapter IV)

ENGINEERING PLANNING

Universal Oil Products Company has made a site investigation and has worked up a preliminary set of plans for the refining of Venezuelan crude to produce aromatic petrochemicals and petroleum products.

In order to be practical from an economic and marketing standpoint, these plans have been drawn up so the core plant will start up and operate with a minimum of difficulty, yet be so designed that side streams can be withdrawn for the separation and purification of petrochemicals as markets are developed or as they can be used by other companies for chemical feed stocks.

These plans include both capital and operating cost estimates, site recommendations, personnel requirements, and an estimated net operating income.

(See Chapter V)

FINANCIAL PLANNING

On the basis of the Universal Oil Products Company's engineering investigation, representatives of E. M. Warburg Company and Kuhn Loeb have worked up a financial plan for this project. This plan provides for maximum participation by citizens of Puerto Rico.

(See Chapter VI)

STATUS OF PROJECT

E 1451

Preliminary planning, selection of key personnel, and all other practical steps have been completed to initiate the project. Necessary assurances have been given to and received from the Commonwealth of Puerto Rico, and raw material supply and marketing arrangements have been made.

Before the construction of the core plant can be contracted, it is necessary to establish that crude petroleum will be available for the use of the company. Under the proclamation of March 10, 1959, "adjusting and Regulating Imports of Crude Oil and its Principal Products into the United States," there was a finding that...

> "The Commonwealth of Puerto Rico largely depends on imported crude oil...and that...the adjustment of imports...should permit imports into Puerto Rico adequate for the purposes of local consumption, export to foreign areas; and limited shipment of finished products to the Continental United States."

For reasons previously outlined, the need of a petrochemical industry for the Commonwealth has been given top priority in the economic development program.

The project needs only a license to import crude oil as raw material for its core plant to become a reality.

REQUEST FOR ALLOCATION

E 1452

A request for the allocation of 60,000 barrels per day of crude oil under the import quota allowance is hereby respectfully requested in order to proceed with this project for the establishment of a petrochemical industry in Puerto Rico.

# # #

E 1453

CHAPTER I

NEED FOR PETROCHEMICAL INDUSTRY

Until recently the growth of the chemical industry in Puerto Rico has progressed rapidly. This progress has been remarkable because of the lack of natural resources on the island. A start has been made in petrochemicals by Union Carbide Caribe and Caribe Nitrogen with the manufacture of ethylene glycol and ammonia respectively.

However, recent plans for additional petrochemical plants have been either postponed or abandoned, and it is apparent that raw materials not otherwise available must be imported and extracted from petroleum.

The natural resources of Puerto Rico have been investigated* and found to be practically non-existant, except for sand, limestone, salt water, fresh water and sunshine. With fertile soil and fertilizer, sugar and its products are produced. This means the available raw materials for a chemical industry are sand, limestone, salt and sugar. Other materials must be imported or extracted from petroleum by a petrochemical industry.

The products which can be extracted from petroleum when combined with the products which can be produced from the other raw materials can form the basis of a thriving and continually growing chemical and

petrochemical community.

Recent industrial development on the island has been primarily in industries requiring female employment. Male employment has increased to some degree, but unemployment among men is still over 10%. Many of the unemployed are high school graduates who are ready and willing, but unable to find work.

The chemical and petrochemical industries are among the most rapidly growing industries today primarily employing male labor. The petrochemical industry is growing faster than the balance of the chemical industry and is accounting for the majority of the new investment in the chemical industry. In the period 1959 through 1961 approximately $3 billion was spent by the chemical industry for new plant construction. Of this, 61.4% was for petrochemical plants, 12.9% related to petrochemicals, and only 25.7% was for non-petrochemical construction.

In 1955 petrochemical production amounted to approximately 15 million tons, and in 1965 it is estimated to be over 40 million tons.

Concurrent with the establishment and growth of such an industrial community will be the redevelopment of a critically depressed area, the employment of male labor, and the establishment of support industries in related fields. This activity will require a continuing need for construction labor as well as predominantly male operating labor as each facility is completed.

The establishment of substantial communities, based upon support industry in the forms of machine shops, pipe shops, metal fabricating and welding shops, and electrical repair shops will also all result in increased male employment.

The need for a petrochemical industry in Puerto Rico is expressed in a report dated September, 1961, by the Commonwealth of Puerto Rico Office of Economic Research, entitled "The Chemical and Allied Products Industry in Puerto Rico"** and quoted in part below:

> "There are several reasons why great importance is attached to the need for an expanding petrochemical industry . . .
>
> 1. A local petrochemical industry could substantially compensate for the island's lack of indigenous raw materials.
>
> 2. The industry affords permanent employment at relatively high wages.
>
> 3. The industry offers predominantly male employment; an offset to the fact that new employment opportunities generated by our development program to date have been largely female jobs (60%).
>
> 4. Because of the magnitude of petrochemical projects, a substantial volume of constructive employment and income is generated in the adjoining areas."

When this report was written, the following chemical and petrochemical projects were contemplated:

Polyethylene by Union Carbide Caribe

Naphthalene by Commonwealth Oil

Phthalic Anhydride by Stepan Chemical

Chlorine & Caustic Soda by Morton Chemicals

These projects have all been either postponed or abandoned. Some have been carried out elsewhere.

Other petrochemical projects recently abandoned or postponed are listed below:

Polyethylene by U.S.I. Chemical Division of National Distillers

Lead Antiknock Plant by Stepan Chemical

These projects may be revived by these same companies or by others if a petrochemical industry is established to provide feed stocks and/or markets for them.

New opportunities are constantly arising. As for example, the Puerto Rico Chemical Company has just announced plans for a 5,000,000 pound per year phthalic anhydride plant. Representatives of this company have told us that the feed stock they require is not available in Puerto Rico and that they must import their requirements. The feed stock they require is one of the petrochemicals we intend to manufacture in more than adequate quantity for their requirements.

The potential petrochemical complex is shown by a series of charts (No. 1 through 10) prepared by the Ralph M. Parsons Engineering Company. Chart 1 shows the primary products (petrochemical intermediates) which can be made and is the index to the other nine charts.

On Chart 1 the top six primary products can be made from either petroleum or natural gas; the lower products can be made only from petroleum.

The company intends to make the petrochemical products which can be made only from petroleum at first. These are the aromatics and the products which can be made from them are shown in Charts 8, 9, and 10.

The end products will eventually range from insecticides, herbicides, and solvents from the chlorinated hydrocarbons to synthetic fibers and film of the "Nylon," "Dacron," and "Mylar" type. The former will supply agricultural and dry cleaning industries and can be further processed chemically to make other chemicals such as Freon, which is used extensively in air-conditioning systems and as an aerosol propellent. The latter is only representative of one of the types of products which can be made. Nylon is the best material for commercial fish nets which could be manufactured for export and to supply the fishing vessels which supply the islands canneries. The list of possible products is beyond the scope of this report, and several volumes would be required for a complete listing of all possible future outlets.

E 1458

*References to Natural Resources of Puerto Rico

Limestone & Marble Resources of Puerto Rico, 1958

Preliminary Report on Silica Sands of Puerto Rico, 1958

Preliminary Report on Calcitic Dolomite of Northern Puerto Rico, 1957

Beachrock in Northeastern Puerto Rico

A Survey of the Geology of Puerto Rico, 1954

Geology of the Carolina Clay Deposit, Puerto Rico

Geology and Ore Deposits of the Keystone Iron Mine Near Juncos, Puerto Rico

Stratigraphy, Sedimentation, and Structure of Late Cretaceous Rocks in Eastern Puerto Rico, 1960

Nickel-Cobalt-Iron-Bearing Deposits in Puerto Rico, 1959

Report of the Bureau of Mines, On the Mineral Resources of Puerto Rico, An Appendix to the Annual Report of The Bureau of Mines for the Fiscal Years 1939-1941

Preliminary Results of Geophysical Exploration for Gas & Oil on the North Coast of Puerto Rico

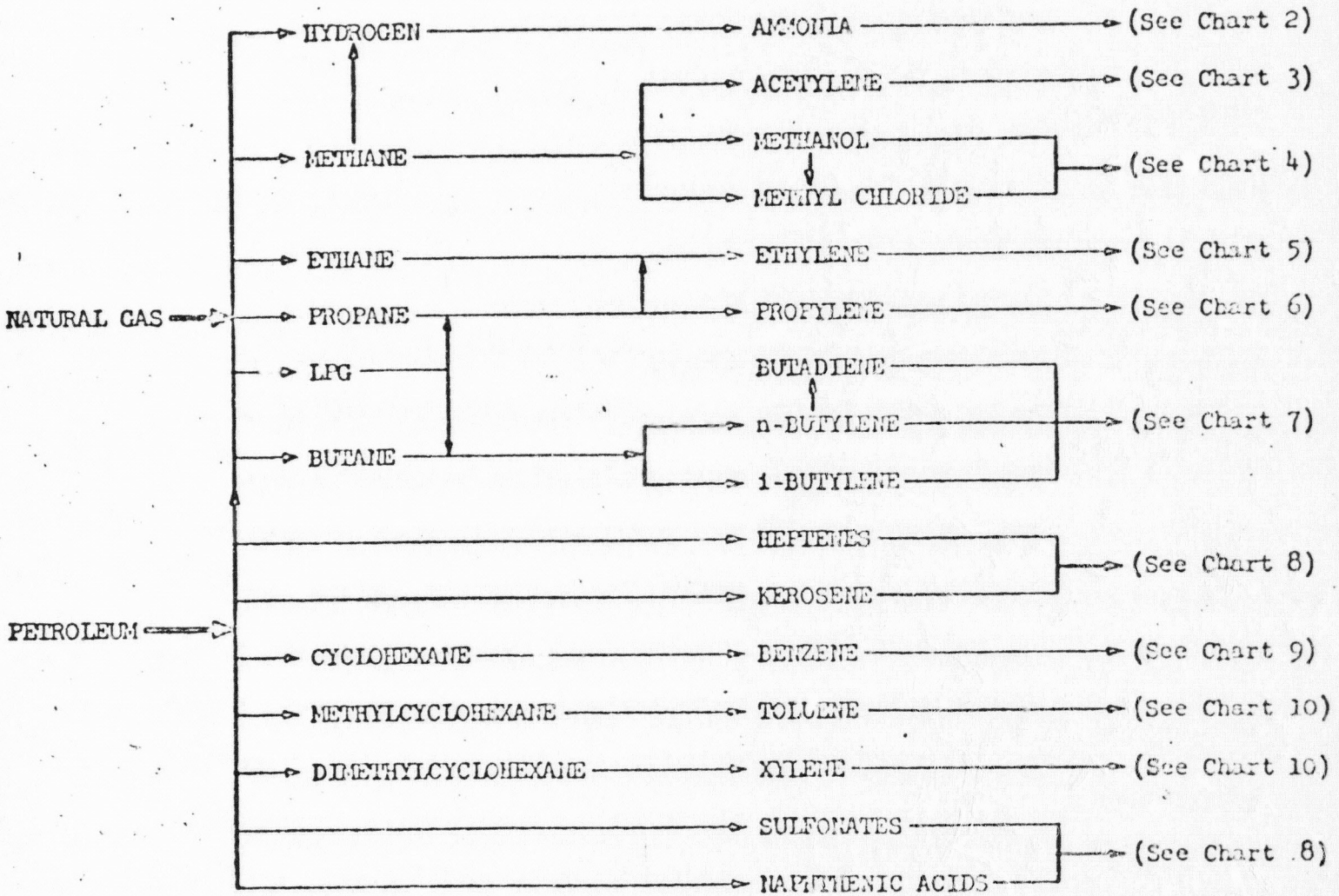
Preliminary Results of Geophysical Exploration for Gas & Oil on the South Coast of Puerto Rico

Industrial & Mineral Development in Puerto Rico, 1959-1962

**For Report in Full - See Appendix A

CHART 1

MAJOR PETROCHEMICAL INTERMEDIATES



E 1459

THE RALPH M. PARSONS COMPANY

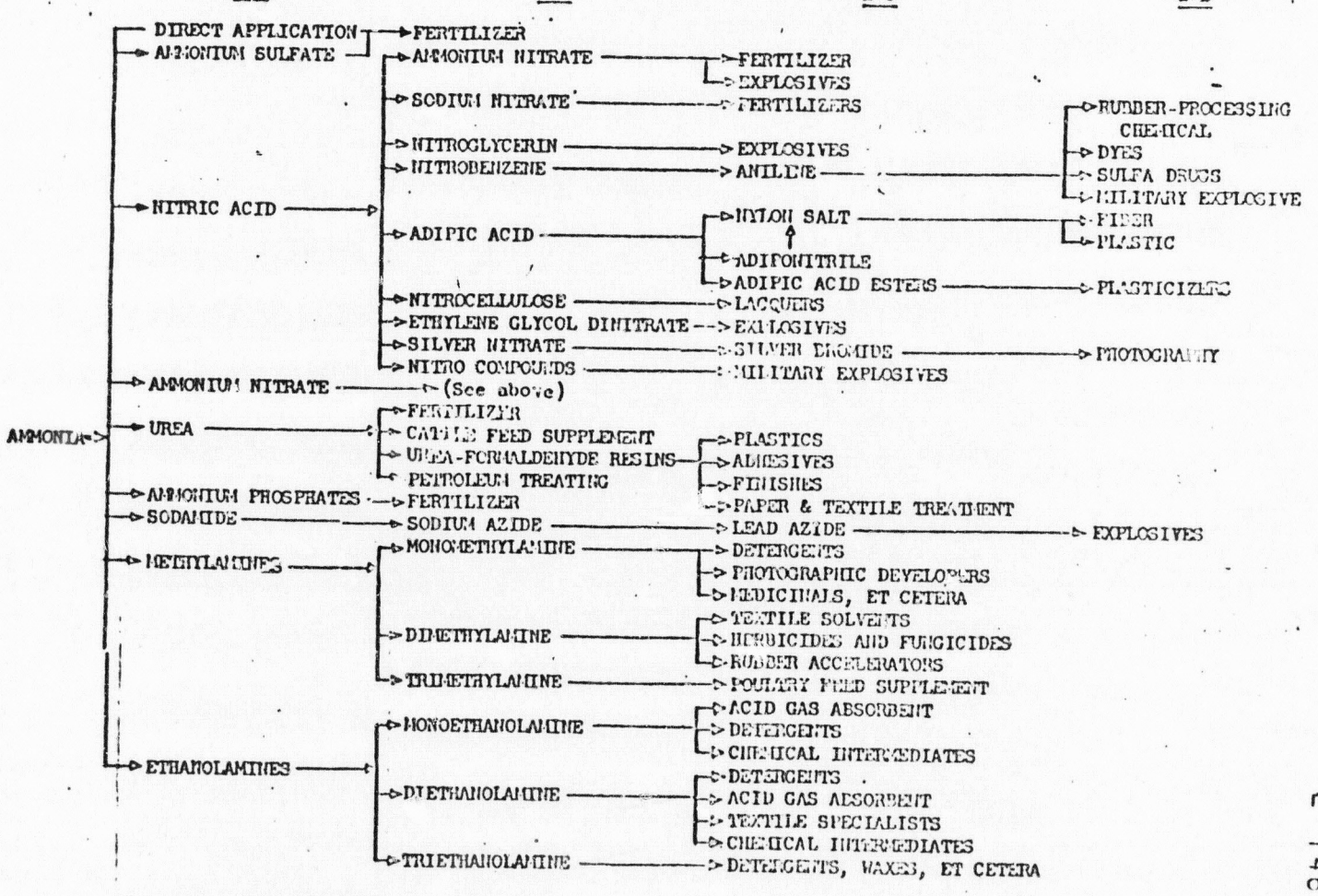


CHART 2
AMMONIA DERIVATIVES

THE RALPH M. PARSONS COMPANY

E 1460

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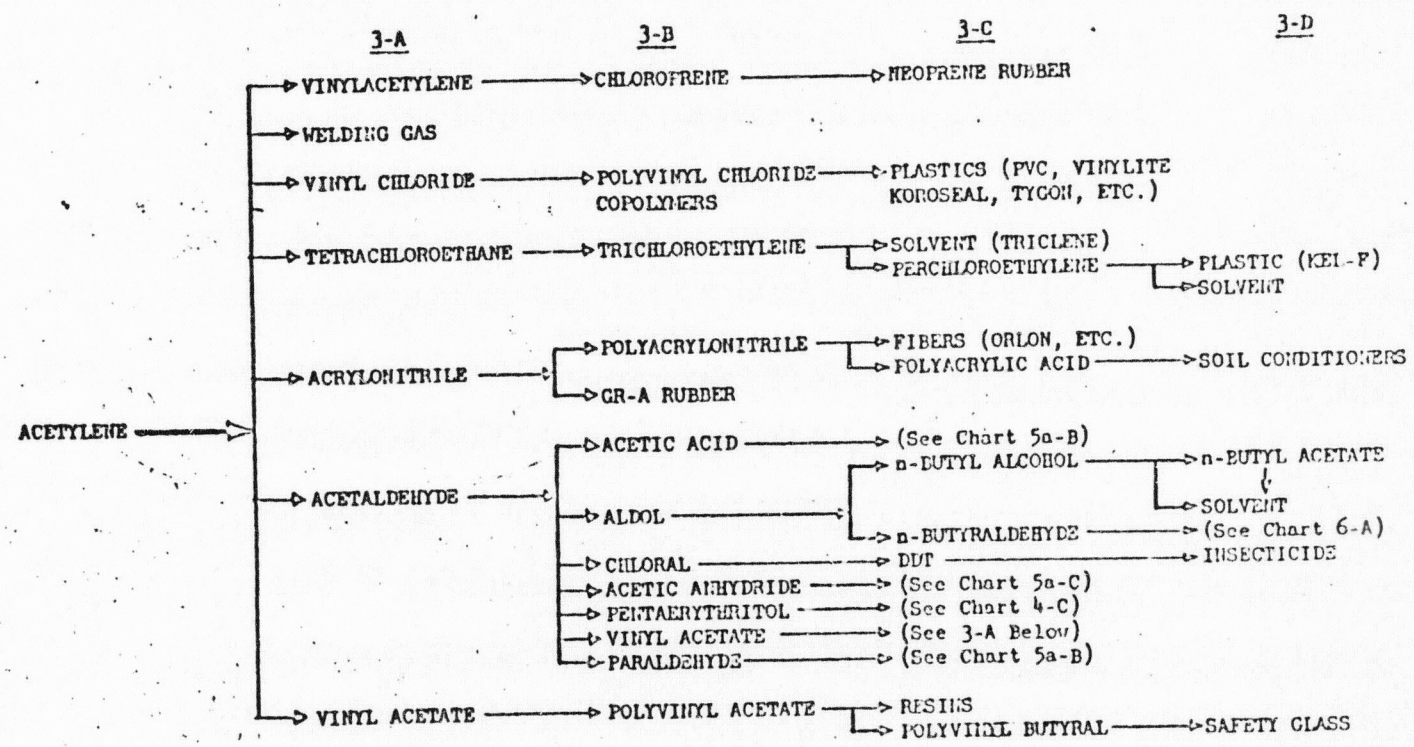

CHART 3
ACETYLENE DERIVATIVES

THE RALPH M. PARSONS COMPANY

E 1461

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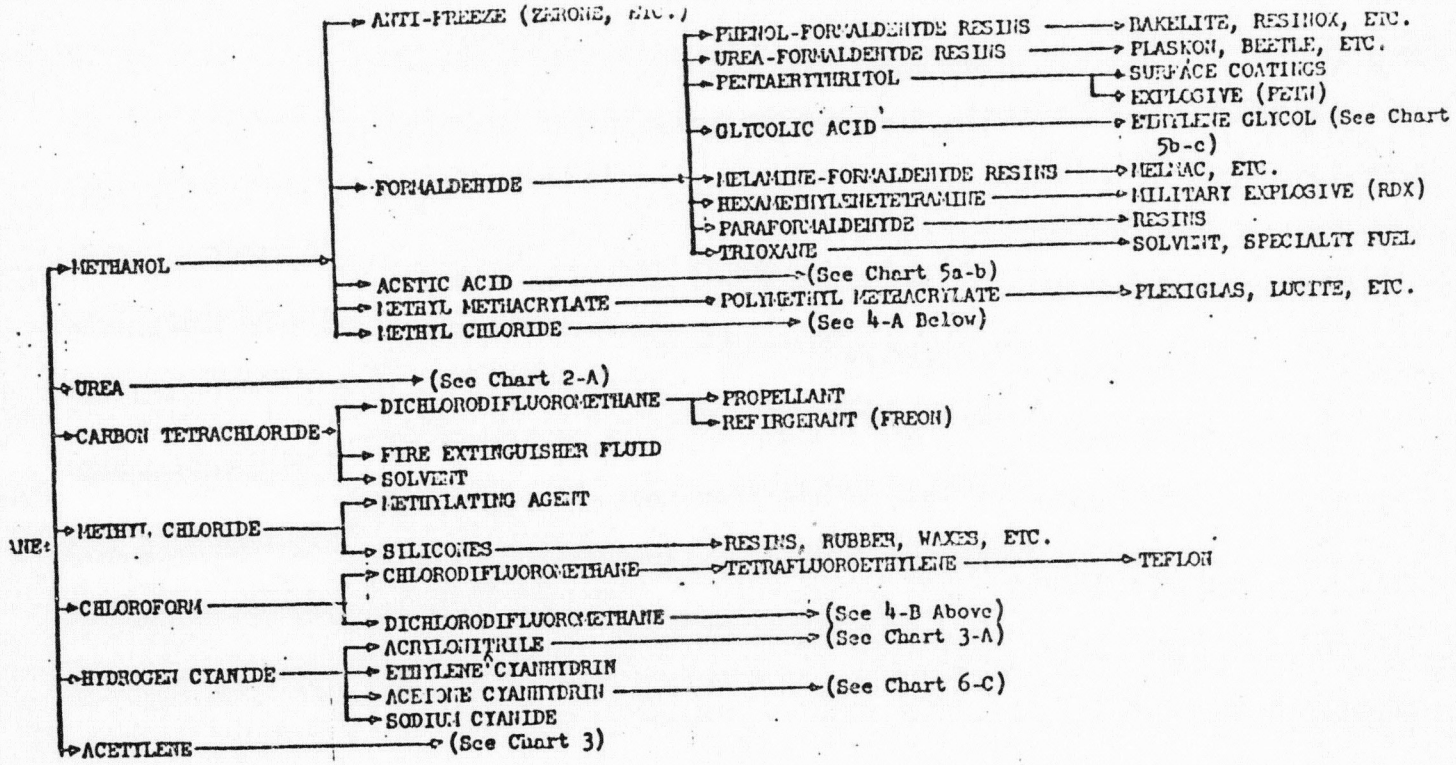

CHART 4
METHANE DERIVATIVES

THE RALPH M. PARSONS COMPANY

E 1462

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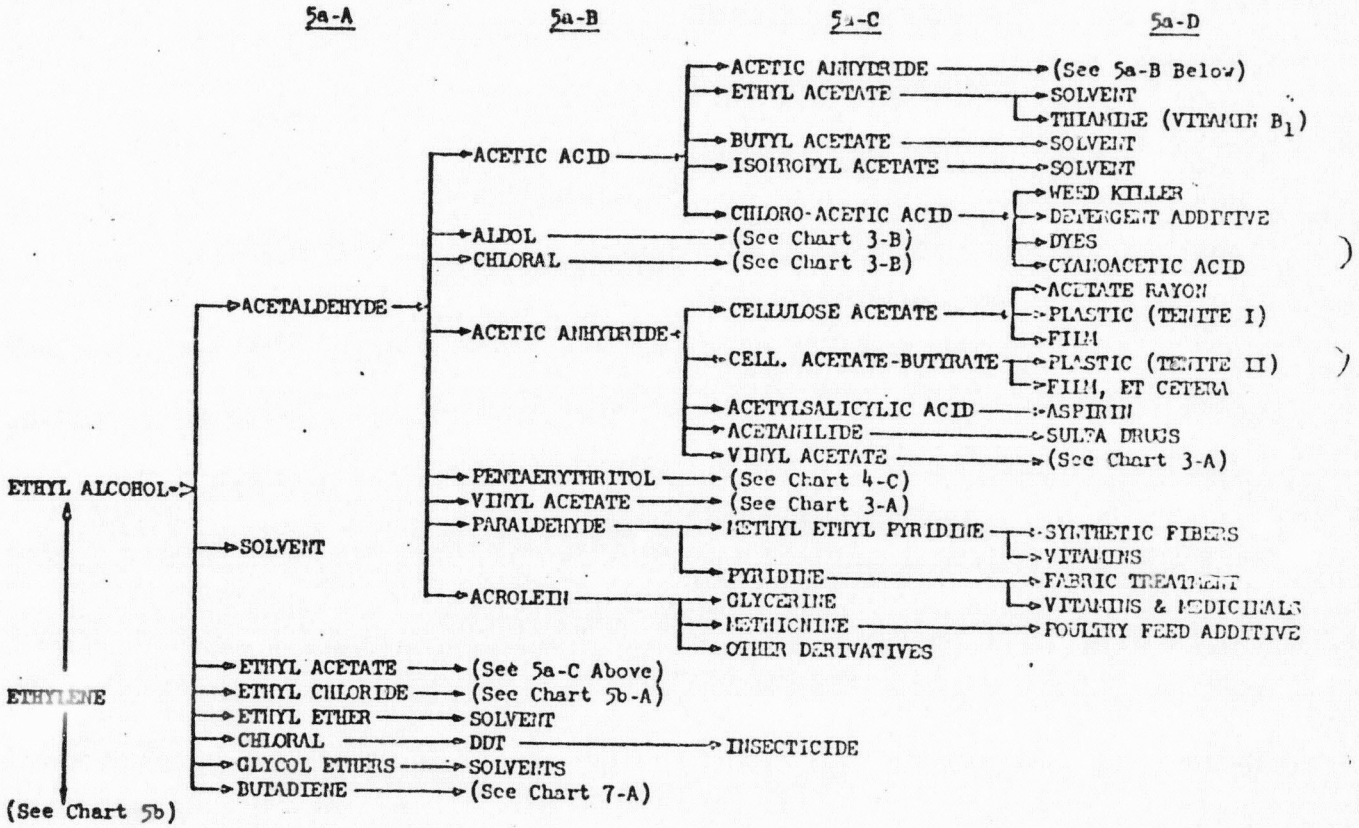

CHART 5a
ETHYL ALCOHOL DERIVATIVES

THE RALPH M. PARSONS COMPANY

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E 1464

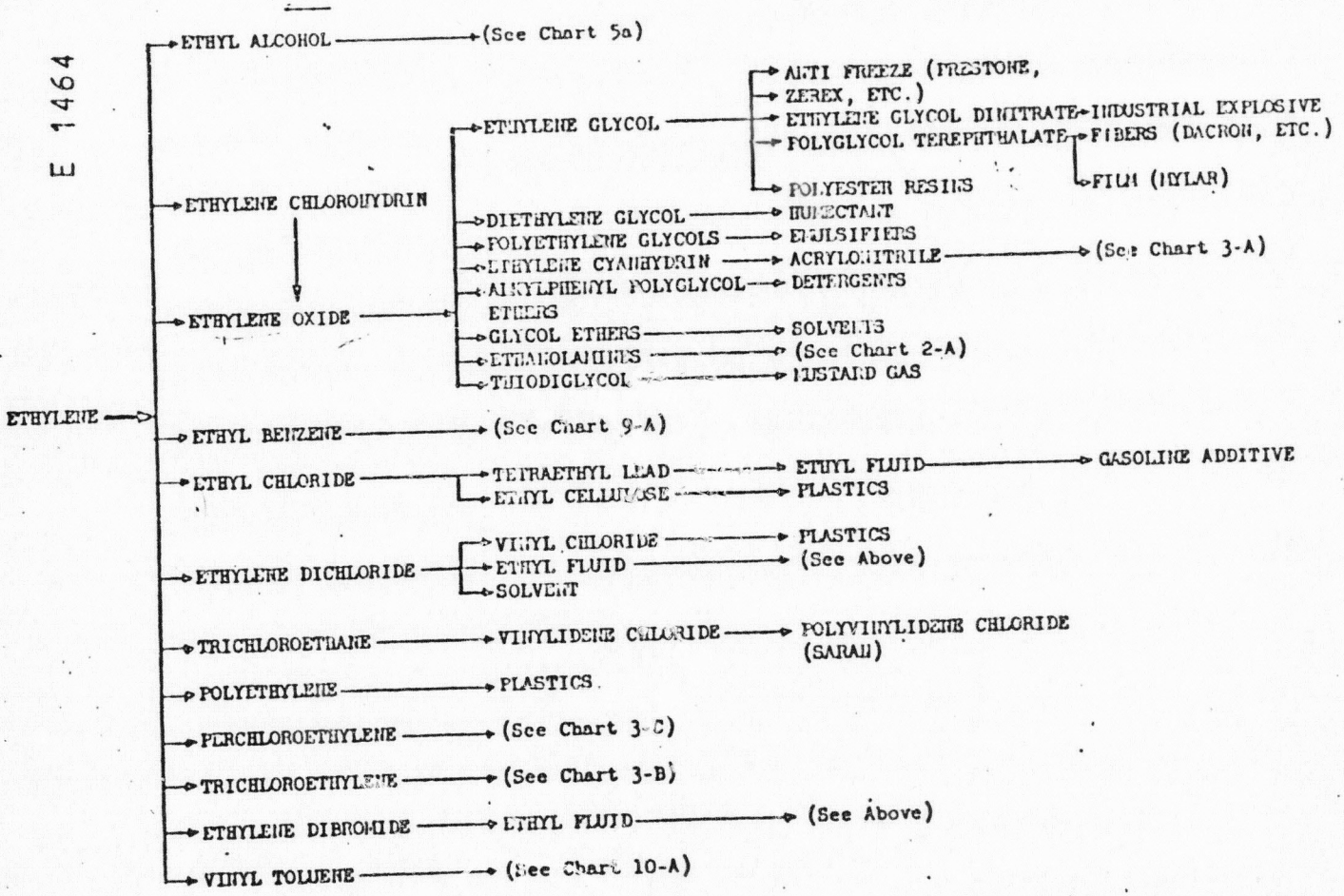

CHART 5b
ETHYLENE DERIVATIVES

THE RALPH M. PARSONS COMPANY

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6-A

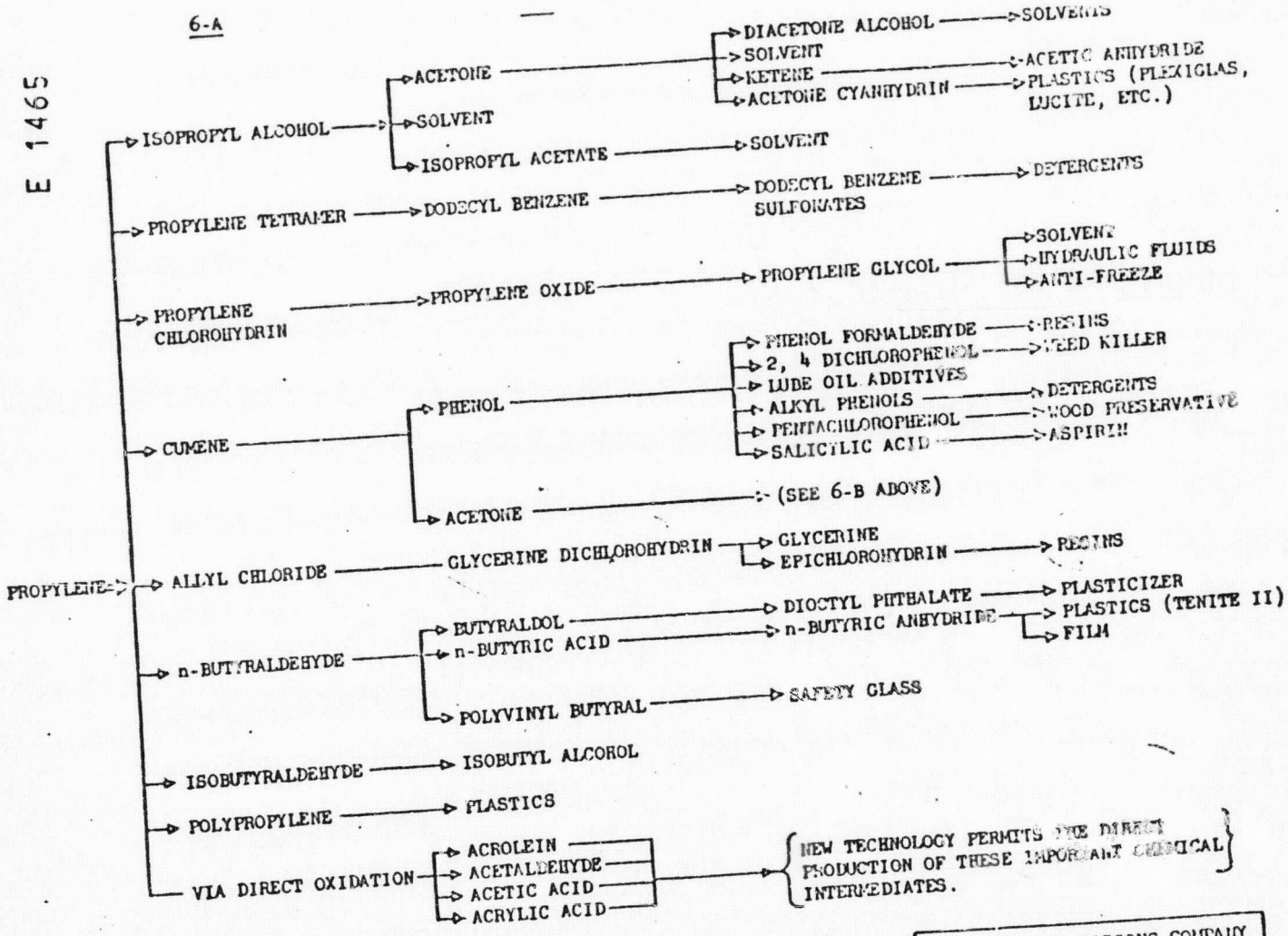

CHART 6
PROPYLENE DERIVATIVES

THE RALPH H. PARSONS COMPANY

E 1465

E 1466

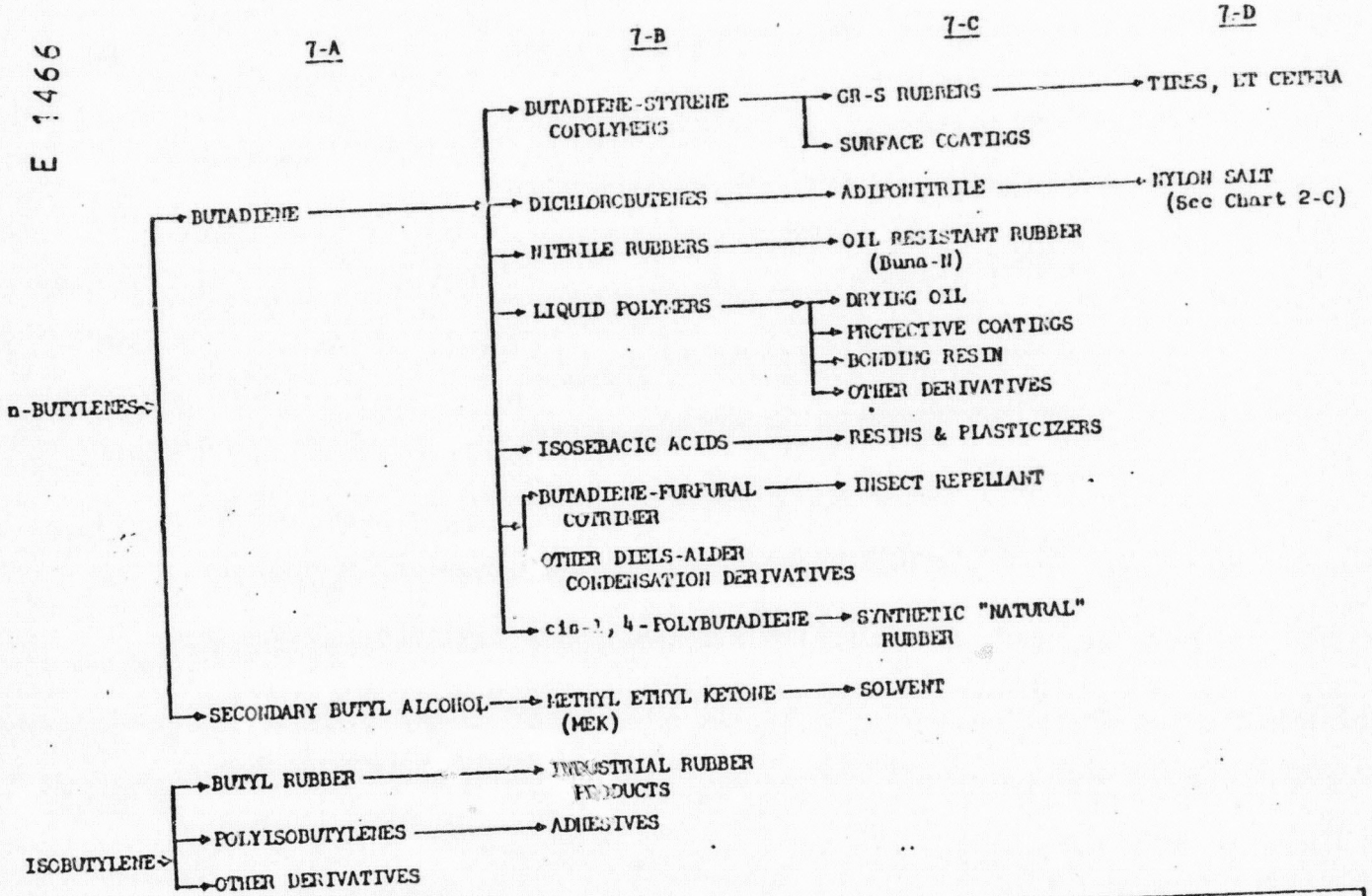

CHART 7
BUTYLENE DERIVATIVES

THE RALPH M. PARSONS COMPANY

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E 1467

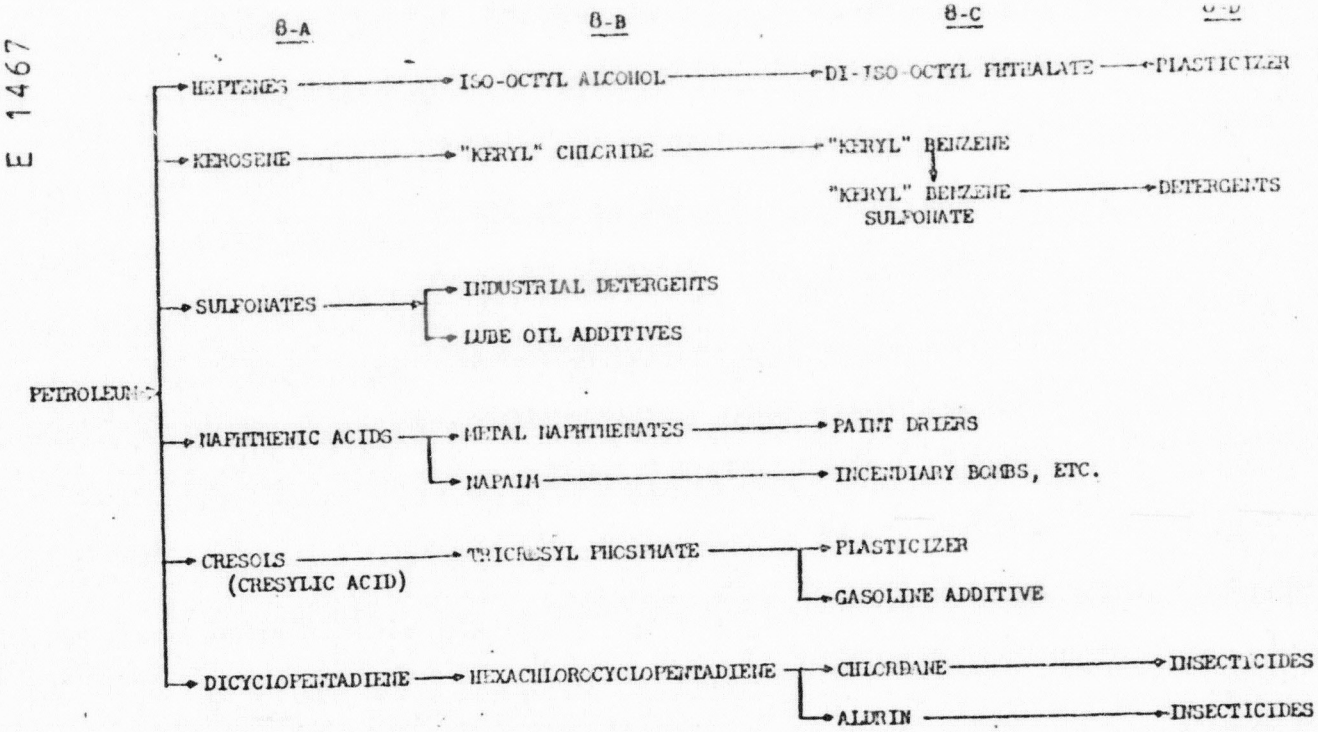

CHART 8
OTHER PETROLEUM DERIVATIVES

THE RALPH M. PARSONS COMPANY

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E 1468

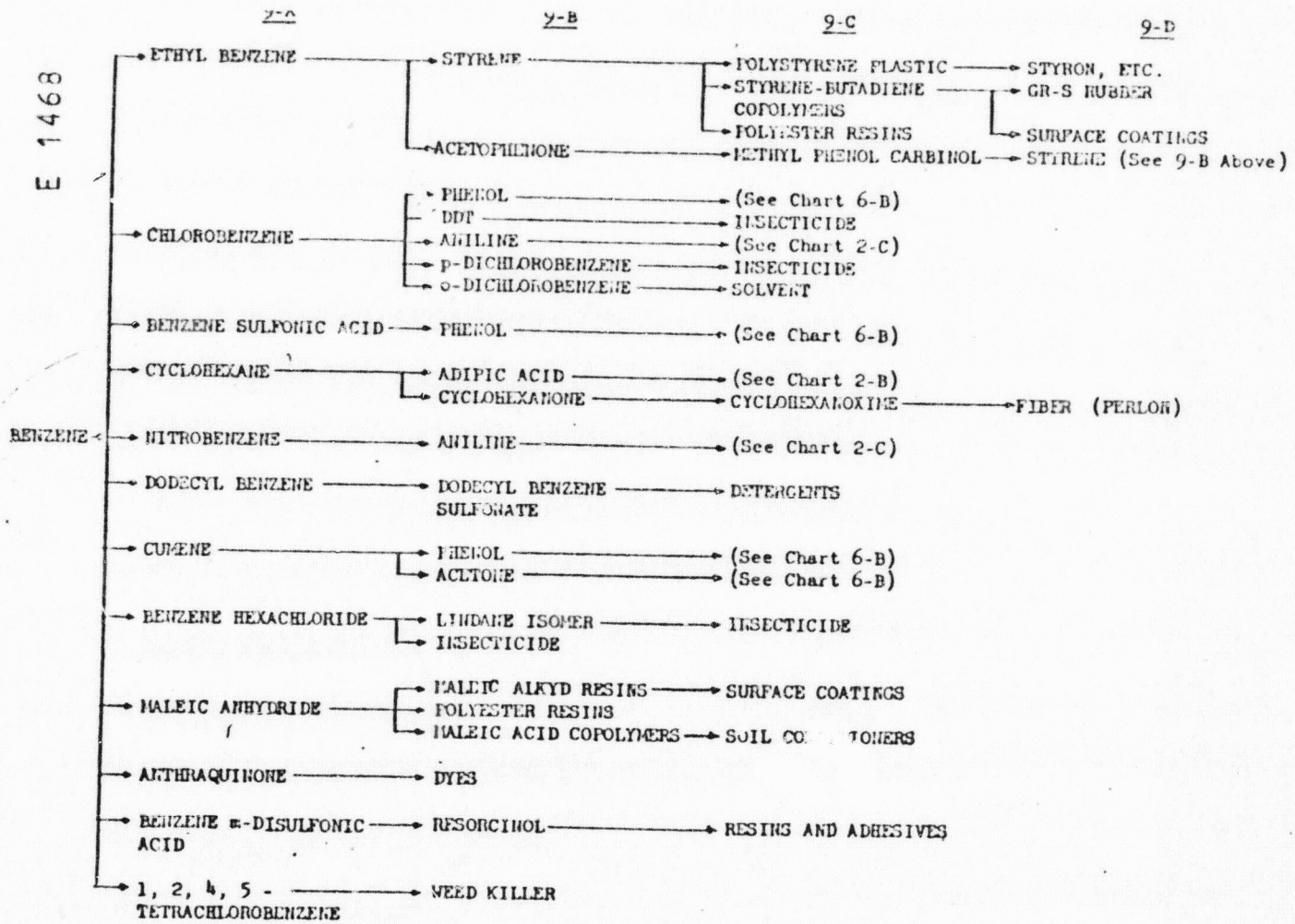

CHART 9
BENZENE DERIVATIVES

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THE RALPH M. PARSONS COMPANY

E 1469

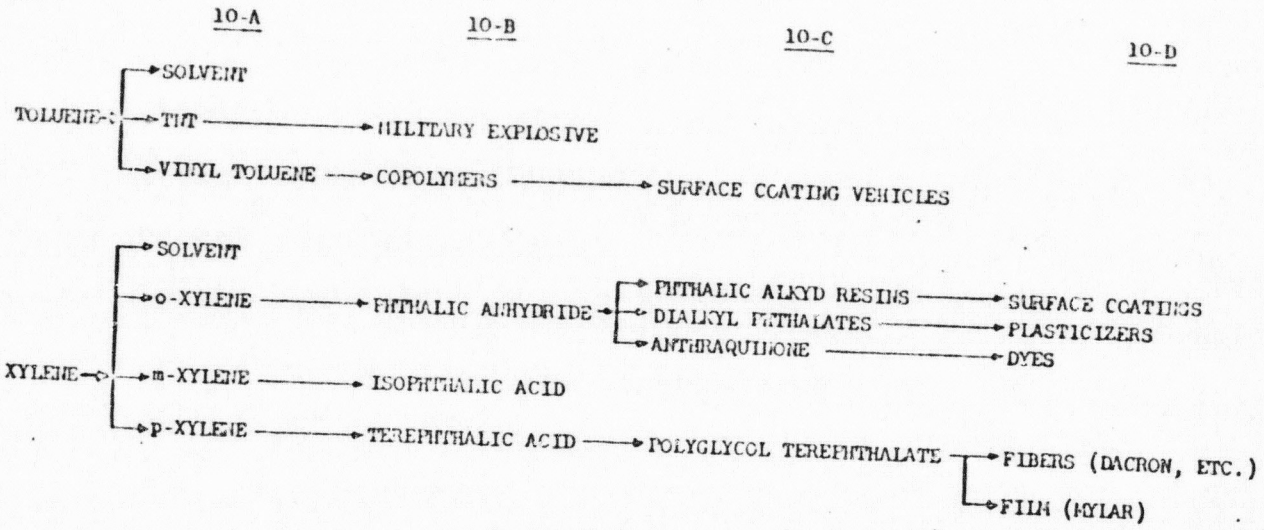

CHART 10
TOLUENE AND XYLENE DERIVATIVES

THE RALPH M. PARSONS COMPANY

E1469

CHAPTER II

CORE PLANT

The first step in the development of a petrochemical industry is to establish a core plant to provide feed stocks and petrochemicals for the prospective petrochemical plants. The latter would be essentially satellites around the core plant which will extract and purify each raw material for each respective satellite plant.

Obviously, the entire complex of core plant and satellites cannot be established at once, but must be developed over a period of time. The question of where and how to start on a practical basis is thus presented.

A core plant is proposed to refine crude oil to produce sulfur, aromatic petrochemicals, chemical feed stocks, and residual petroleum products. This plant would be designed in such a manner that side streams can be withdrawn and additional petrochemicals and chemical feed stocks separated and purified as soon as markets can be developed or agreements reached for satellite plants. In this way the quantity of petrochemicals will increase and the petroleum fuels will decrease as the petrochemical industry grows.

Some LPG will also be made, and the balance of the products will be made as soon as demand can be developed.

Sulfur is not normally considered a petrochemical because it usually occurs naturally and is one of the basic chemical building blocks. However, because of no known deposits in Puerto Rico, sulfur is now imported. Since crude oil contains small amounts of sulfur, a sulfur recovery unit is planned as part of the core refinery.

Salt recovered from the ocean by solar evaporation is available from both the southwestern part of Puerto Rico and from other nearby islands. Salt is the raw material required for two other basic chemicals: chlorine and caustic soda.

It is expected that a chlorine and caustic soda plant will be built as soon as the plans for the core plant are announced. Chlorination and sulfonation of petroleum products plays a large part in the petrochemical industry and, together with existing requirements for chlorine, caustic soda and sulfuric acid, will certainly create sufficient demand for the establishment of these basic chemical industries.

The key then to a chemical and petrochemical industry in Puerto Rico is a core plant which is established for the express purpose of extracting chemicals, chemical feed stocks, petrochemicals, fuels and other petroleum products from crude oil. This plant is not just another refinery,

but a plant which is the first step in the development of a petrochemical industry and which is part of a company which is committed to a policy of continuing its efforts in the growth of a chemical and petrochemical industry for Puerto Rico.

# # #

CHAPTER III

SUPPORT OF THE COMMONWEALTH

In August, 1961, after an extensive survey of the chemical industry in Puerto Rico, the Economic Development Administration of the Commonwealth made it known to representatives of the company that a core plant for a petrochemical industry was sorely needed to provide raw materials otherwise not available for that industry. Representatives of E.D.A. have made this known to the Department of the Interior. They have started construction of port facilities in Mayaguez. They have agreed to clear and provide land for the core plant and set aside other land nearby for the satellite plants. They have agreed to provide housing, roads, and to redevelop a critically depressed area. They have agreed to assist support industries to provide services for the core plant and satellite plants. In essence, they have agreed to provide or assist in all items other than those facilities to be used solely by the core plant.

The Commonwealth has described the project for the establishment of a core plant for a petrochemical industry "as of the highest economic importance," and has requested that it move ahead "with dispatch."

# # #

CHAPTER IV

COMMERCIAL IMPLEMENTATION

The Puerto Rico Oil & Petrochemical Company (PROPCO) has been incorporated in the Commonwealth of Puerto Rico by both Puerto Rican and United States parties for the express purpose of building a core plant for the development of a petrochemical industry. Its intent in this regard is contained in the first paragraph of its charter, as follows:

> "The company is formed for the express purpose of developing a chemical and petrochemical industry in Puerto Rico. It will design and build a refinery to produce, initially, sulfur, aromatic petrochemicals and petroleum products. This refinery will be the basis of and feed plant for the petrochemical industry as it grows. The refinery will be designed so that petrochemical side streams can be withdrawn in the future. When these side streams are needed, the company will install the necessary additional facilities to purify them. The company will also promote additional chemical and petrochemical projects related to the development of the petrochemical industry."

In the event that any particular petrochemical feed stock cannot be produced economically, the company has agreed to produce any such petrochemical feed stock on a quasi-public utility basis.

Directors of PROPCO include qualified and interested parties in both Puerto Rico and the United States.

Both the officers and operating personnel of PROPCO have been selected on the basis of their proven performance in the chemical, petrochemical, petroleum and engineering and construction industries. Resume's of the Directors and Officers are attached hereto.

For the core plant to be economic and practical, raw material supply and marketing arrangements must be made.

Phillips Petroleum Company has agreed to supply crude and to market all petrochemicals and petroleum products not consumed by the petrochemical industry (See letter attached). Sulfur will be marketed by the company, probably to Caribe Nitrogen Company who now imports about three times the sulfur capacity of the core plant.

Monsanto Chemical Company has identified its interest in using 15,000 to 20,000 bbl/day of a 30% wax distillate cut if the company can meet its requirements as to quality and time (See letter attached).

Discussions have been held with Mobil Chemical, U.S.I., Division of National Distillers, Celanese Corporation, and Allied Chemical. These companies have asked to be kept informed of developments and would like to give serious consideration to building petrochemical plants in Puerto Rico if a core plant is built.

The core plant will necessarily produce petroleum fuels. To assist in marketing these outside the Continental U.S., a fueling station is planned for ships passing through the Mona Passage. This station is planned for both commercial and U.S. Naval vessels, and for tanker shipments of military fuels.

Captain O. W. Stafford SC USN Director, Purchase Division, reported at the September 21, 1962, meeting of the National Petroleum Refiners Association that $300 million is spent annually by the U.S. Navy for overseas fuels. At this same meeting, Col. R. W. Beer, USAF, Director, Planning and Comptroller Division, submitted an excellent series of charts showing details of military procurement which showed the Caribbean to be the largest single source of military tanker cargoes. Details of the reports at this meeting are attached.

If the core plant is built, the company will consider building a tetraethyl lead antiknock plant large enough to supply all the antiknock requirements of Puerto Rico. Imports were over 4 million pounds in 1960* for the two existing refineries. The core plant would use an additional 1 million pounds which would make a 5 million pound antiknock plant practical.

*From data received from the Economic Development Administration of the Commonwealth of Puerto Rico.

Initial sales volume is expected to be slightly over 50% petrochemical and "non-quota" petroleum fuels and slightly under 50% petroleum fuels which may be imported into the continental United States. As satellite petrochemical plants are built petrochemical sales will, of course, increase. A breakdown of the initial sales forecast is as follows:

Wax feed stock 30% (gross)	10%	Net
Other petrochemicals	18%	
Fuels to Military & Mona Passage vessels	25%	
Fuels to be shipped to continental U.S.A.	47%	
Total	100%	

E 1478

Board of Directors

Mr. Nathan M. Shippee - Chairman

Mr. Jorge Bird

Mr. Rafael Carrion

Mr. Hector Ceinos

Mr. Oscar Chapman

Mr. Walter Gruber

Mr. Frank Larson

Mr. John Little

Mr. John Neikirk

Mr. Gustavo Podilla

Mr. Edward Willey

Mr. Thomas Young

Officers & Directors

E 1479

Puerto Rico Oil & Petrochemical Co.

President Chief Operating Officer	Mr. Thomas Young, Professional Chemical Engineer. Formerly a partner in Singmaster Breyer, consulting engineers, and a Vice President of Houston Chemical Company.
Vice President Technical Director	Mr. Herman W. Behme, Chemist. Formerly of Stauffer Chemical and Dorr-Oliver Company, and Vice President of Houston Chemical Company.
Vice President Operations	Mr. A. Dale Fischbeck, 30 years experience in production, operation and marketing of petroleum, currently serving Phillips Petroleum in this capacity.
Vice President Marketing & Public Relations	Mr. John W. Little, formerly Director of Advertising, Wellington Sears Company, and currently Vice President Marketing, Prudential Oil Corporation.
Vice President Finance	Mr. Frank Larson, Director of Prudential Oil Corporation and Treasurer of Avco.
General Counsel	Mr. Oscar Chapman, Formerly, Secretary of Interior, a partner of his own law firm in Washington, D. C.

Financial Consultants	E. M. Warburg Company, New York, New York
Accountants	Price Waterhouse Company

PHILLIPS PETROLEUM COMPANY

BARTLESVILLE, OKLAHOMA

E 1481

November 13, 1962

STANLEY LEARNED
PRESIDENT

Prudential Oil Corporation
21 West Putnam
Greenwich, Connecticut

Attn: Mr. N. M. Shippee, Chairman

Gentlemen:

In connection with the Puerto Rico Oil and Petrochemical Company's petrochemical complex to be built in Puerto Rico, Phillips Petroleum Company is prepared to:

1 - Furnish 30,000 to 60,000 barrels per day of crude oil for charge stock;

2 - Purchase the refined petroleum products not consumed in the petrochemical operations;

3 - Counsel with you and assist, if you wish, in the design and construction and operation of the proposed facilities.

Whenever you desire, we shall be glad to have our representative work with you to negotiate and complete contracts.

Very truly yours,

MONSANTO CHEMICAL COMPANY
HYDROCARBONS DIVISION

E 1482

800 NORTH LINDBERGH BOULEVARD
ST. LOUIS 66, MISSOURI

November 19, 1962

Mr. E. J. Willey
Prudential Oil Corporation
21 West Putnam Avenue
Greenwich, Connecticut

Dear Mr. Willey:

Your letter of November 12 has been received.

We do have a potential requirement for a waxy feedstock for petrochemical manufacture. However, this material will be utilized in our pending project only if:

(1) Quality satisfactory
(2) Price within specified limits
(3) Availability clearly determined within next few months.

If these conditions cannot be met, our project will move in a completely different manner, involving different raw materials.

The desired waxy feedstock should:

(a) Be a 600-900°F. vacuum distillate
(b) Contain 30% wax
(c) Be as low in sulfur as possible
(d) Pass a final evaluation in our process.

If successful in "putting together" an operation based on such a feed, 15,000-20,000 bbl./day of the distillate would be required.

BEST COPY AVAILABLE

E 1483

We would certainly be interested in evaluating a sample of any proposed raw material. If whole crude is furnished, a five-gallon quantity would be needed; if 600-900°F. cut can be supplied (this is more desirable), one-gallon would be sufficient. In either event, sample should be shipped to:

Dr. B. L. Williams
Monsanto Chemical Company
Texas City, Texas

We should receive several weeks' advance notice on any shipments.

Your interest in working with us is appreciated; of particular interest is your statement that our pricing requirement can be met. We will look forward to hearing from you further.

Sincerely,

Norman J. Lewis

Norman J. Lewis

NJL/vc

E 1484

NATIONAL PETROLEUM REFINERS ASSOCIATION

FALL MEETING

PROCEEDINGS OF DEFENSE PETROLEUM SUPPLY CENTER PRESENTATION
(September 21, 1962)

REMARKS BY
Colonel Leon Stann
on behalf of
Rear Admiral T. L. Becknell, Jr.

DPSC'S ROLE IN PETROLEUM
Colonel R. W. Beers, USAF
Director, Planning and Comptroller Division

PROCUREMENT OF PRODUCTS
Captain O. W. Stafford, SC, USN
Director, Purchase Division

PROCUREMENT OF SERVICES
Colonel S. O. Benner, USAF
Director, Service Contracts Division

LEGAL ASPECTS OF DPSC CONTRACTS
C. F. Pollock
Counsel

Presented at the
NPRA FALL MEETING
Washington, D. C.
September 19-21, 1962

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E 1485

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OPENING REMARKS

by

Colonel Leon Stann, USAF

E 1486

On behalf of Admiral Becknell and the Defense Petroleum Supply Center, I wish to express our appreciation for the privilege of meeting with the National Petroleum Refiner's Association. Admiral Becknell asked me to extend his sincere regrets that he is unable to attend. As you know, the Admiral is on an extended tour of temporary duty in Far East Asia.

We regard meetings such as this as a very valuable channel of communication between the Petroleum Industry and the Military. I hope that during the question and answer periods that you will feel free to raise any points that need clarification or amplification. We are here to listen and learn as well as to present information. The more thorough the exchange of information, the better equipped we will be to insure that the U.S. Military Forces are adequately supplied with the types and quantities of petroleum products they require.

I am certain that you recognize the importance of petroleum to the economies and defense efforts of the Free World; and, you need no reminder of the importance of petroleum to those countries that lie behind the Iron and Bamboo Curtains.

Our chances of success or failure in any future conflict hinge on oil. The sobering truth is that petroleum availability can make or break any military operation in modern war. With the dramatic, but still very limited exception of nuclear-powered naval vessels, the Armed Forces of all Nations are committed exclusively to hydrocarbon fuels to power their complex weapons systems.

The magnitude of military petroleum consumption is staggering by any standard of comparison. At present, our peacetime usage is running at the rate of approximately 36 million gallons a day. This is an increase of 21 million gallons a day since 1950. For example, jet fuel requirements have risen from zero 14 years ago to the present level of 17 million gallons a day. The modern military machine literally thirsts for oil. Guns, tanks, ships, planes and even most missiles need petroleum fuels and lubricants -- and in great quanitites. Concurrent with increased consumptions, there has been a gradual evolution toward greater complexity and more stringent requirements with respect to petroleum products, and their application to equipment. Materials and equipment are being stressed to their limits to meet the performance requirements of the aero-space age. Accordingly, fuels, lubricants and hydraulic fluids will have to withstand greater stresses - some known today - others to be specified in the future. Thermal stability, storage stability, cleanliness, luminometer number, BTU content, and many other characteristics are becoming increasingly important. We are continuously developing new specifications and amending existing ones. In most instances the requirement are becoming tighter. The capability of industry to produce more and better products is becoming increasingly important.

I mention these points not to impress you -- but rather to drive home the basic point that given the global commitments of the U.S. and the key importance of petroleum to support our forces, we - meaning both the Military and Industry - are faced with a tremendous logistic problem. We dare not fail, for nothing less than survival is at stake! We have depended heavily upon the petroleum industry in

the past, and have always received outstanding support. I think it is accurate to say that we expect to remain heavily dependent upon the Petroleum Industry as far into the future as we can presently see. I am confident that we can continue to depend on your outstanding support!

Once again I would like to express our sincere appreciation for being able to participate in this meeting.

xxx

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DPSC'S ROLE IN PETROLEUM

by

Col. R. W. Beers, USAF

E 1488

The Defense Petroleum Supply Center rang in the year of 1962 with a transfer from Department of Navy to Defense Supply Agency management and our name was changed from the Military Petroleum Supply Agency to its present designation.

Since the first of January, procedures have changed but there has been no change in the basic objective of providing effective logistic support to the Military forces at the lowest possible cost to the taxpayers.

The Defense Supply Agency, or DSA to use its alphabetical short title, attempts to achieve this basic objective under the principle of decentralized operations with centralized policy and guidance. At present, DSA has two service activities - Traffic Management and Logistics, and line Commodity Supply Centers - Petroleum, Subsistence, Constructions, Medical, General Supplies, Industrial Supplies, Clothing and Textiles, Electronics Parts and Automotive Parts. These DSA field elements perform a wholesaler function for the Military Services.

To perform its mission, DSA currently employs approximately 21,000 military and civilian personnel. About 550 of them are employed in DSA Headquarters. By 30 June 1963, it is anticipated that the total employment will rise to approximately 25,300. About 1,000 will be military personnel from the four Services.

DSA Supply Centers now manage an inventory of 262,021 line items valued at 1.75 Billion dollars. This will increase to 1,200,000 items with a value of 2.6 billion dollars by the close of Fiscal Year 1963.

DSA also administers Defense-wide programs for cataloging, standardization, inter-servicing and surplus disposal which covers about 3.5 million items in the Military Supply System.

Studies to determine the range of additional items susceptible to integrated management by DSA are underway. Included are industrial production equipment, common chemical supplies and aeronautical spare parts. The total inventory value of those items is nearly ten billion dollars.

I mentioned previously that the DSA Supply Centers operate on a decentralized basis. DSA Headquarters provides overall leadership, coordinates policy and procedures and exercises the management functions related to budgeting, fiscal control and accounting, and programming.

This resumé of the Defense Supply Agency provides a bird's-eye view of the organization of which the Defense Petroleum Supply Center is a member.

Now let us look specifically at the mission, functions, and operations of the Defense Petroleum Supply Center in the world-wide petroleum logistics systems. (1) In our mission there is a definite distinction and differentiation between our scope of operations and that of DSA Commodity Supply Centers.

E 1489

First, the scope of our commodity assignment is presently limited to the extent that neither ownership nor funding by a single stock fund is provided for the management of all petroleum products. We do not compute new requirements, nor do we exercise stock financing. These functions are still the responsiblity of the individual services. However, in May 1961, the Deputy Secretary of Defense assigned the responsibility for centralized management including stock funding of packaged petroleum products, some 938 items - lubricants, grease, oil, etc. We are in the process of finalizing our procedures for this responsiblity which we will implement 1 October 1962.

Secondly, we differ in our scope of operations from other Commodity Centers in that our responsibility does not end at the waters edge of the Continental U.S. We procure, furnish services, and distribute petroleum products on a world-wide basis. I will elaborate on this later in the briefing.

(2) The principal functions assigned are to -

1. Conduct world-wide procurement of products for the Military Services and some other non-Military Government Agencies.
2. Determine source of product for Army and Navy, arrange tanker transportation and place Army/Navy bulk orders for overseas and East Coast requirements.
3. Coordinate interservice supply support (world-wide responsibility).
4. Contract for storage and services.
5. Direct the procurement inspection program.
6. Coordinate cataloging.
7. Coordinate standardization nationally and internationally (NATO).
8. Coordinate petroleum training, and
9. [illegible]s the Commodity Manager on packaged petroleum products 1 October 19[illegible]

(3) Chart on Governmental Agencies involved in petroleum

(4) DPSC Organization and Functions

To carry out our responsibilities we are presently authorized 212 civilians and 22 officers. Recently we have undergone a reorganization to afford a better posture for assumption of these increased responsibilities.

Planning and Comptroller Functions have been combined under a single division. I wish to point out that the function of industrial mobilization planning is retained by the Office of Petroleum Logistics Policy headed by Admiral Biggs.

Procurement Functions are divided between our Purchase Division, which contracts for products, and the Service Contracts Division, which contracts for services connected with storage, dispensing and testing of petroleum products, etc.

Total world-wide military petroleum requirements during Fiscal Year 1962 rose to a post World War II peak of 317.8 million barrels of product. This vast military usage is equivalent to a consumption of over 70 gallons of petroleum for each man, woman and child in the United States.

Domestic military aviation fuel consumption accounts for approximately 66 per cent of all jet fuel and 51 per cent of all aviation gasoline used in the United States.

Distribution is responsible for coordinating the management in conjunction with MSTS and the Services of bulk petroleum movements by tanker. These movements constitute approximately 50% of our procurement.

Technical. Under our Technical Division are centered the responsibilities for cataloging, standardization, procurement inspection and quality control, and technical support to the overseas commands. I feel that we have made enviable progress in standardization with an item reduction of approximately 40% since 1957.

(5) Chart on Tanker Carriers

This Chart depicts the magnitude of the management of tanker operations. The octopus indicates the flow of tankers. I wish to emphasize that we move product from the Caribbean and Gulf to the East Coast of the United States, and from the Gulf to the West Coast, in addition to movement to the overseas areas.

(6) Chart on Procurement

It is interesting to note, as depicted by this Chart, that because of the economic situation in oil - and we like to say as a result of better efficiency in procurement - we are buying more product for less money. The average volume over the past three Fiscal Years of products procured has been 288 million barrels per year.

(7) Chart on Distribution of the Procurement Dollar

In spending our procurement dollar, where does the money go? This Chart indicates a break-out based on volume and cost per gallon, the amount that we are currently expending of the defense dollar for procurement by major product.

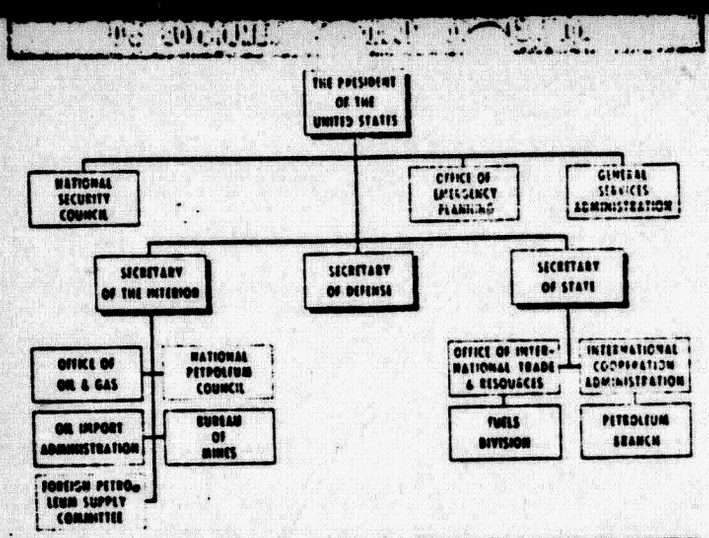
(8) Chart on Trends of Fuels

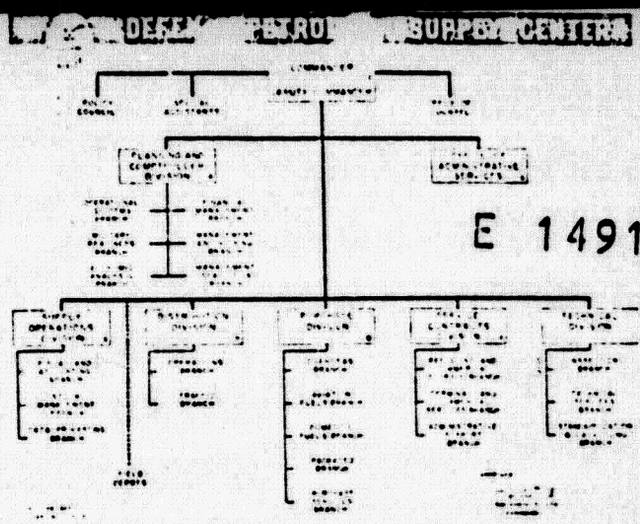
We have discussed procurement from the dollar point of view, and this Chart indicates percentage-wise the amount of volume by product of the average of 288 million barrels annually.

(9) Chart on JPO Organization

As mentioned earlier, our scope of operations, unlike other Commodity Centers, carries us beyond the tidewaters of the United States. In carrying out these responsibilities, unique to the commodity of petroleum, we have petroleum organizations overseas to assist us. These organizations are called Joint Petroleum Offices, and were established by the Joint Chiefs of Staff because of the vital importance of insuring POL logistical support to the Unified Commanders. The officers on the Staff of each Unified Commander provide logistical support planning, and direct operations pertaining to petroleum for support of the theater mission. The Offices are jointly staffed by members of the four Military Services. They act as the ordering Agency in placing demands on DPSC for petroleum products developed by the Component Commanders and consolidated by the Unified Commander to meet the operating and war reserves required for support of Military Forces in the overseas areas.

In summary, the petroleum supply chain from initial determination of requirements to final delivery into ships, aircraft, tanks and trucks around the globe contains many organizational links. The strength of this petroleum supply chain has been crises tested. Its toughness and flexibility are attributable to the United efforts of the men and women in the Government organizations and the petroleum industry.





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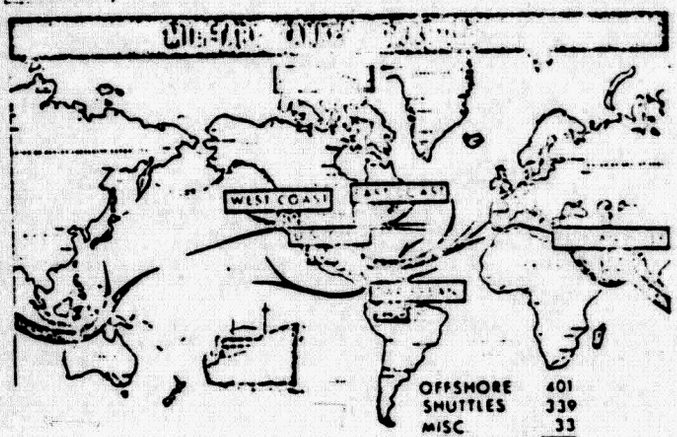
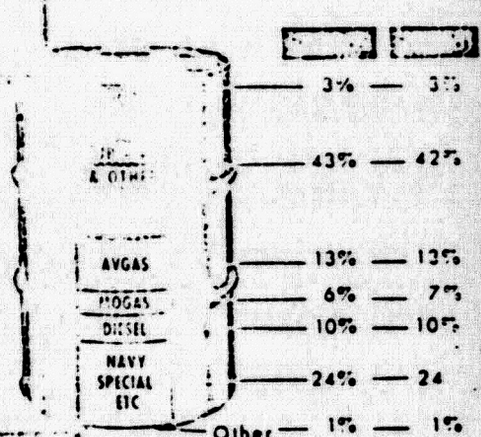
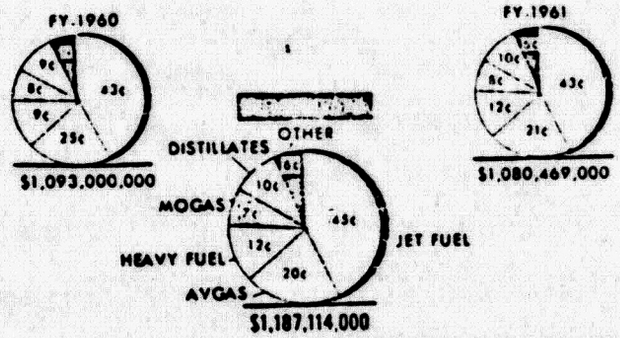
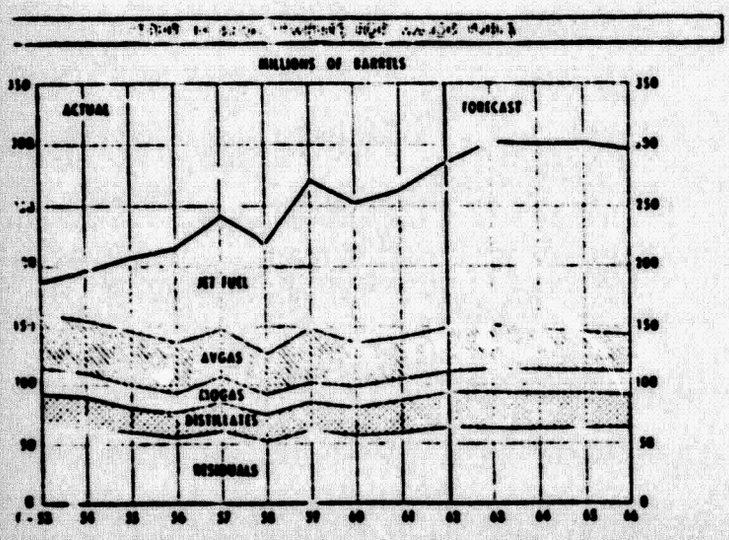


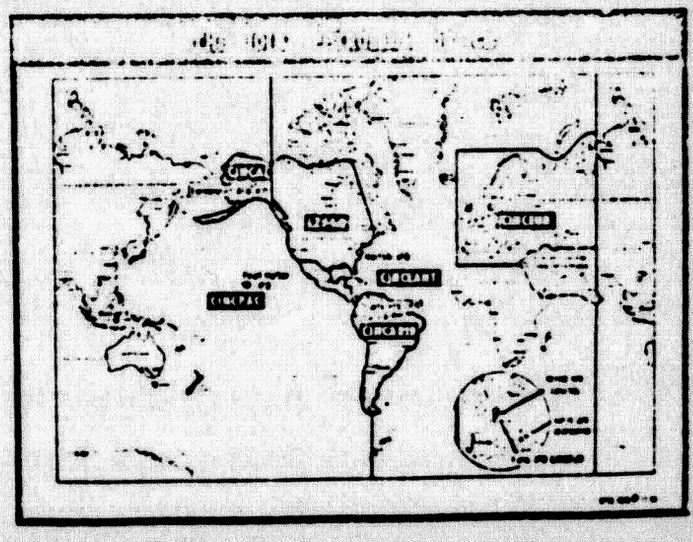
FISCAL YEAR 1962
317,816,000 BBLS

FISCAL YEAR 1961
279,871,000 BBLS









PROCUREMENT OF PRODUCTS

by

Captain O. W. Stafford, SC, USN

E 1492

Our basic tool for supplying petroleum product to the Armed Forces is what we call an open-end contract. Simply stated an open-end contract is a document which permits the using activities within the Services to order directly from the contractors what they need when they need it. The Military Services give DPSC the estimated quantities and using locations and these in turn form the basis for awarding the open-end contracts.

For purposes of discussion, our procurement effort is divided into two parts: Domestic and Overseas. First, we will discuss domestic procurement.

Insofar as practicable, we take advantage of the vast commercial distribution system for petroleum product that exists in the United States. One of the documents we use for this purpose is called a post-camp-and-station contract. This contract permits the using activity, large or small, to order its motor gasoline, diesel oil, kerosene, and heating oil from a local source of supply as the need arises. A similar arrangement is in effect for supplying lubricating oils and greases.

We are obliged to use a different system of supply for our ships and planes. Although some features of the post-camp-and-station arrangement are retained, the supplying of ships and planes is largely accomplished through centralized ordering within the Services for delivery to government-owned or government-controlled terminals.

Navy Special, as many of you know, is the fuel oil for our ships. It is a specification product made especially for us. At the seaports where we have no facilities for refueling ships, we contract for Navy Special delivered into our vessels. However, the bulk of Navy Special is bought for government-owned coastal terminals. We have an annual import quota of about one and one-quarter million barrels of black product and we apply Navy Special against this quota.

Turning now to aviation requirements we have three principal aviation fuels: JP-4 jet fuel used almost exclusively by the Air Force; JP-5 used by the Navy, and 115/145 aviation gasoline used by all the Services. To give you some conception of the procurement and distribution pattern I have selected JP-4 for comment. Any one of the three fuels would serve but JP-4 has more of an appeal because of the volume and because of the industry-wide interest in this product.

We buy JP-4 for domestic use twice a year by means of advertised procurement. The volume is tremendous by any standards: the last two procurements have each been for about 55 million barrels of product. In these days of millions and billions we tend to lose our perspective. In terms of tank cars, our semi-annual procurement of 55 million barrels of JP-4 would form a train reaching from Washington D.C. to Chicago.

The requirements pattern for JP-4 calls for delivery to ocean terminals, barge terminals, pipeline terminals and for other large volume locations as well as to the smaller installations. The Services submit requisitions in June and

December of each year and DFSC makes contracts for six months periods, April through September and October through March We have an annual import quota of clean product of about 12 million barrels and we apply JP-4 against this quota.

Now let us look at our overseas procurement. In other presentations you have been told that our annual volume of procurement is in excess of one billion dollars. About three hundred million of this is for overseas procurement. Overseas procurement is defined as procurement from an overseas source of supply; however, it should be emphasized that the majority of these procurements are from American firms doing business abroad.

The source of supply for our forces overseas are the Caribbean, the Near East, local sources within the foreign countries themselves and in the case of aviation gasoline the United States

Let us consider the various areas of the world requiring petroleum support. First, the European Area comprising the United Kingdom, France, Germany and Spain. In Great Britain there is a British-owned pipeline extending throughout the country where most of our bases are located and product is delivered through this line. Contract coverage has been arranged for those bases that cannot be served by the pipeline.

Our forces in France and Germany are supplied by a U.S. operated pipeline extending from Donges, near Saint Nazaire on the Atlantic Coast of France, to Germany. As in Great Britain, those locations that cannot be supported by the pipeline are serviced by other means.

The United States Forces in Spain also receive their product by U.S. operated pipeline. The terminal for this line is at Rota near Cadiz on the Atlantic Coast of Spain.

In the Mediterranean Area we have forces in the interior of Italy, Greece and Turkey and the SIXTH fleet is based at Naples. The bases are supplied by local delivery within those countries and to a limited extent from refineries in the Near East. A long-term contract for Navy Special and JP-5 with an American refiner in Italy meets the needs of the U.S. SIXTH Fleet in the Mediterranean.

Turning now to the Far Pacific, our forces in that area of the world are supplied from refineries in the Near East. The requirements for our Army in Korea for the SEVENTH Fleet in Formosa Straits and for the U.S. Air Force in the Far Pacific are satisfied largely through deliveries of product to storage locations in Japan, the Philippines, Okinawa, Guam, etc.

We have covered most of the areas of the world except our military installations North of the U.S. border. Those located in the interior of Canada are serviced principally by Canadian firms on a post-camp-and-station basis. Requirements for Labrador, Newfoundland, Greenland and Iceland come almost entirely from the Caribbean.

There are two additional types of contract coverage quite essential to our needs that I have not mentioned. One of these is the into-plane contract. This is merely another name for refueling service at commercial airports throughout

the world for U.S. government planes, either civilian or military. These contracts will be found in far away places such as Addis Ababa in Ethopia or Christchurch in New Zealand. We also have what we call world-wide bunkering contracts. These are the surface ship counterparts of the into-plane contracts. Everywhere that U.S. Navy ships or MSTS ships are likely to go we have anticipated their fuel requirements with a contract which enables them to be refueled and serviced.

This in brief is how DPSC furnishes petroleum support to the U.S. Armed Forces.

PROCUREMENT OF SERVICES

by

Colonel S. O. Benner, USAF

E 1495

I. INTRODUCTION

In addition to buying petroleum products described by Capt. Stafford, the Defense Petroleum Supply Center buys services connected with petroleum. We procure these services on behalf of the Army, Navy, and Air Force, and we let contracts throughout the world. We presently are administering some 140 contracts: (flash slide 1) the chart shows the concentration of the 118 contracts we have in the States. I'll show you the overseas locations later.

Our buying programs cover several different types of services. They include the operation of government-owned terminals; commercial storage services; drum and container filling; laboratory testing; re-refining; aircraft refueling; and miscellaneous services, such as the blending of anti-icing additive into government-owned jet fuel.

Many of you presently have service contracts with the center and are providing the Military with excellent services. Many of you are potential suppliers. In some of our programs there isn't much competition. I would like to describe the services involved in each program in hope of developing more industry interest.

II. GOVERNMENT-OWNED TERMINALS

(Flash slide 2) one of our programs is for the operation of bulk storage terminals owned by the Air Force. The contracts under this program are usually for 12 months, but with the starting dates staggered throughout the year. The contracts are let by formal advertising and are reserved for small business. We presently contract for the operation of 10 of these terminals, as shown on the chart. The terminals range in size from 100,000 barrels at Tacoma, Washington, to 1,200,000 barrels at Tiverton, Rhode Island.

In operating these terminals, the contractor performs all the services incident to receiving, storing, and shipping government-owned fuel, plus everyday housekeeping and maintenance of the facility itself. Except for the small tools required in maintenance, little fixed investment is necessary. Basically, the contractor provides the personnel necessary for all terminal operations. This might include only a terminal superintendent, several operators, and a guard.

For the operation of all 10 terminals, the government pays some $600,000 a year. At present, we have 47 companies on our mailing list for this program; but many are not active bidders. All of the contracts are presently divided among only 4 companies.

III. COMMERCIAL TERMINALS

A second buying program in the service contracts division is for storage

services in commercially-owned bulk terminals. (flash slide 3) This chart shows the location of the eleven commercial terminals contracted for on behalf of the Navy. (flash chart 4) the dots on this chart represent the 24 single year storage contracts for the Air Force; on a later chart six terminals for the Army will be shown.

Under many of these commercial storage contracts, the government uses only one or two storage tanks, while under others we occupy the whole terminal. The government is quite flexible as to the specifications of tanks provided under commercial storage contracts.

In furnishing storage services, the contractor provides the required storage, and also handles the government-owned product as it enters and leaves the terminal. Terminal personnel are required to operate the storage being used by the government in much the same manner as the operations required in the government-owned terminals I mentioned earlier.

We let these contracts by negotiation, and any company, large or small, may participate. Prices vary considerably, depending on the size and location of the terminal, the complexity of its operation, ancillary operations, and the competition available in the area.

Though these contracts are initially let for just a 12 month period, most contain unilateral government options to renew the services for several succeeding one year periods. The procurement regulations prohibit contracts of this type for more than one year's duration.

Competition in this program is restricted geographically, since the Military service requiring the storage specified the area in which the terminal must be located. Often there is good competition; often not. At one location I visited recently nearly a dozen different companies had existing storage available. In many areas, however, we have had to look hard for suppliers.

There are presently 28 companies providing single year commercial storage services for the government. Though there are over 100 firms on our mailing lists for all locations, in most areas the likely suppliers are very few.

Most of our single year commercial storage contracts are for the use of existing storage. Occasionally, however, we have a requirement in an area where there is not sufficient existing storage. Then, in order for the contractor to perform the services necessary in providing storage for the government, he must first build the tanks. Although the contract calls for storage services only, we recognize in the negotiations the contractor's costs of construction. Of our 41 single year commercial storage contracts, 6 have some element of construction costs included in their service charges.

IV. MULTI-YEAR COMMERCIAL STORAGE

We have eight multi-year commercial storage contracts. These are the result of requirements for storage in areas where there was no existing storage and where no commercial requirements for petroleum storage were foreseen. Because of the

poor prospects for future commercial business, industry was reluctant to build terminals with only a one year guarantee of government use. On the other hand, the government did not desire to bear the entire construction cost in one year. Consequently, we secured legislation permitting firm contracts up to 5 years, provided the storage facility to be constructed met certain criteria on dispersal and hardening.

As shown on the chart, marked by diamonds, mainly across the Canadian border, there are 8 of these contracts presently in operation. The 8 terminals range in size from 90,000 barrels to 1,000,000 barrels. At present we know of no new requirements for services of this type.

V. DRUMMING

(Flash slide 5) The dots on this chart show the commercial storage sites for the Army. As indicated by the "D's", at some of these sites, there is also provided drumming and can filling services. We have 10 drumming contracts: 8 for the Army and 2 for the Air Force. The contracts are for one-year, usually, with government options to renew for several succeeding years.

In drumming, the services performed by the contractor include receiving and inspecting empty drums or cans, storing empty drums, filling drums with government product, storing the filled drums, and loading them aboard government-furnished transportation. The contracts usually provide for the government to pay for each of these services separately.

For instance, for each drum handled we might pay to receive it, so much a month to store it, and so much to fill it and load it for shipment.

Eight companies presently are providing these services for the government. Although more than 70 firms have indicated an interest in this program and are on our mailing lists, geographic factors sometimes result in little competition in some areas. In general, drumming is desired in coastal locations.

VI. LABORATORY TESTING

(Flash slide 6) We also procure laboratory testing services at commercially-owned labs for the Air Force. As indicated by the chart, we presently have contracts in the U.S. at 20 labs. These contracts are very small monetarily. They are let once a year by formal advertising.

Under these contracts, the labs perform all sorts of tests and sample analyses on government petroleum products. Some contracts provide for as many as 40 different tests. The contractor is paid for each test performed.

16 different firms presently have lab service contracts with the center. These firms vary in size from small single proprietorships to the major oil companies. Our invitations for bids are mailed to 87 companies. Even with this number of interested firms, we have trouble every year getting adequate responses to the testing IFB. This year we were unable to get lab services at 5 locations.

E 1498

RE-REFINING

A very small program is for the re-refining of government-owned used aircraft engine oil This is primarily an Air Force program. The contracts are let by formal advertising and are re-advertised yearly. Under these contracts, the contractor re-refines used aircraft engine oil to produce grade 1100 lube oil. The services required of the contractor all take place at his refinery. There he receives used oil from government transportation, stores it in bulk storage tanks, and later re-refines it for distribution back into government petroleum stocks. We presently have only 3 contracts for these services as shown on the chart by the dots Of the 25 known suppliers of this service, only 5 are active bidders. We would especially like to interest other companies since the Air Force's re-refining requirements, like the lab ones, are never completely met.

VII. AIRCRAFT REFUELING

(Flash slide 7) Still another of the services we contract for is aircraft refueling for the Navy As shown on the chart, there are 25 Naval air stations across the country which have private industry refueling its aircraft. These contracts are generally for a 12 month period, although we stagger awards throughout the year. These contracts are totally reserved for small business. They are let by formal advertising.

The contracts call for the contractor, using its own tank trucks and personnel, to fill its trucks at the station fuel depot, transport the government fuel alongside the aircraft in the refueling areas, and, as required, to defuel aircraft, all as directed by the station commanding officer. This is a 24 hour a day, 7 day a week operation. The contractor is paid basically by the month for these services. Presently, there are about 16 companies actively bidding for contracts in the program. All 25 contracts are held by 10 companies. In some locations there is still little competition.

VIII. OVERSEAS

(Flash slide 8) We also have 22 contracts for services to be performed overseas, as shown on the chart. The services provided by these contracts are mostly of the same types as those performed in the States; that is: commercial storage, drumming, and laboratory testing. The contracts are let through negotiation.

Some of the overseas contracts are unusual. For example, we presently have several contracts calling for the injection of anti-icing additive into existing stocks of Air Force jet fuel.

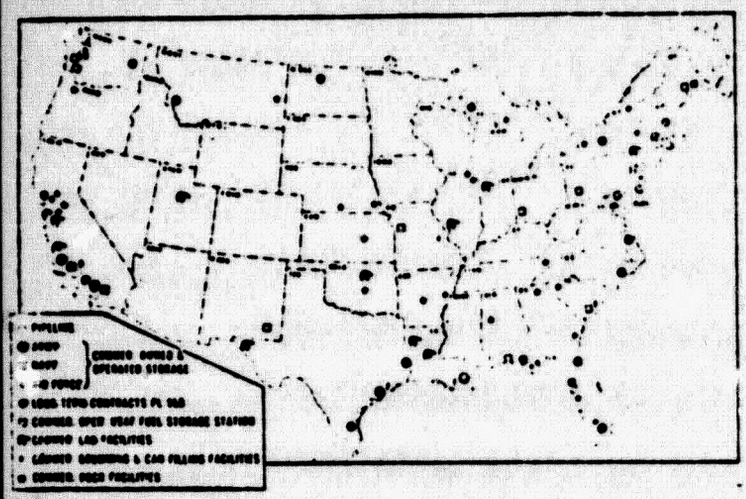
Under these contracts, the contractor provides the additive, men, and machinery necessary to inject a specified amount of additive into the fuel.

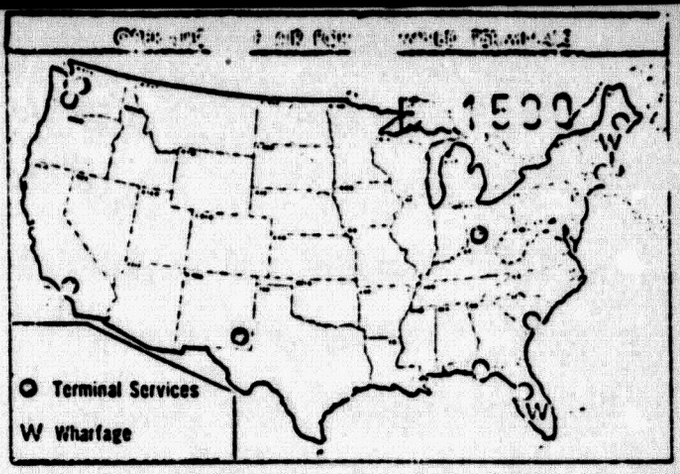
CONCLUSION

I should point out that our goal is to provide the armed forces with good

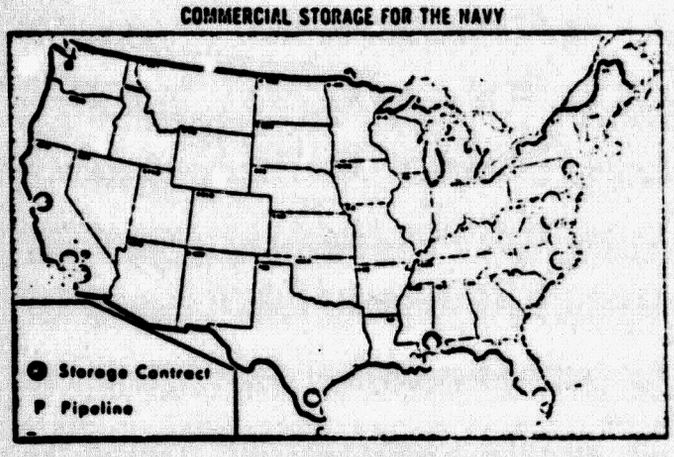
petroleum services at low cost. We've found that the best method of doing this is through competition. We welcome proposals from companies having a capability to perform any of the services I've described. The Army, Navy, and Air Force develop their own requirements. We will be glad to sound them out on any proposal from any company. We welcome letters of inquiry or visits to our offices on any matter concerning these programs. Many firms which began doing business with us in only one program are now participating in 3 or 4.

So, if your company is doing business with us now, make sure you're receiving solicitations for all our programs you are interested in. If you're not doing business with us or drop in for more information on our programs and to get on our bidder's mailing list.



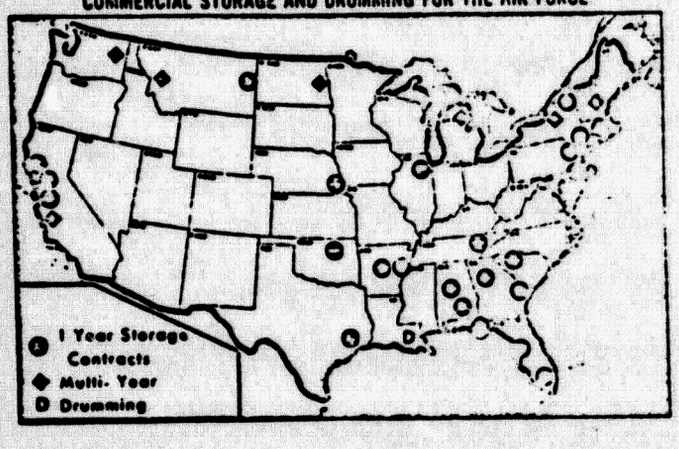


COMMERCIAL STORAGE FOR THE NAVY

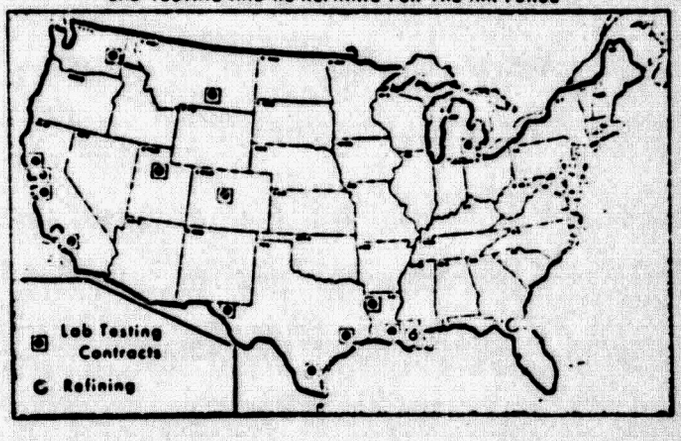


COMMERCIAL STORAGE AND DRUMMING FOR THE ARMY

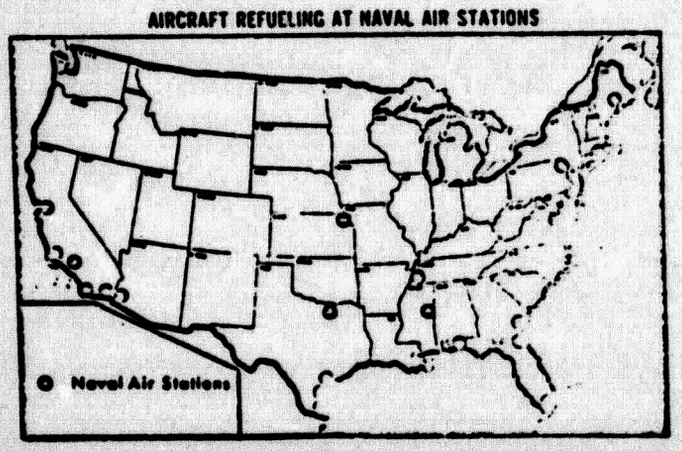
COMMERCIAL STORAGE AND DRUMMING FOR THE AIR FORCE



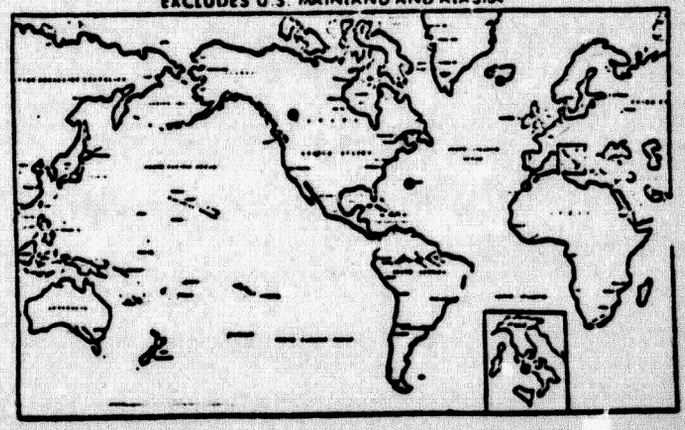
LAB TESTING AND RE-REFINING FOR THE AIR FORCE



AIRCRAFT REFUELING AT NAVAL AIR STATIONS



SERVICE CONTRACTS - WORLD-WIDE
EXCLUDES U.S. MAINLAND AND ALASKA



LEGAL ASPECTS OF DPSC CONTRACTS

by

E 1501

C. F. Pollock

I will briefly discuss two subjects: the first being the Comptroller General's decision of last November concerning the small business set-aside program in jet fuel procurement: the second being the long range impact of government's contract terms upon industry standards.

I had hoped to be able to also comment on the nondiscrimination clause of our contracts and on the results of the compliance reports which your firms have submitted to the president's committee on equal employment opportunity. However, I must advise that I have been unable to develop sufficient information to discuss the matter today.

SMALL BUSINESS

Last November 17th, in response to a formal protest, the Comptroller General rendered an opinion as to the legality of certain aspects of our small business set-aside procedures for jet fuel procurement.

The Comptroller General considered three basic questions: First, whether partial set-asides were legally authorized by Congress. Second, whether the set-aside awards made by the Defense Petroleum Supply Center in the particular instance involved in the protest, resulted in higher prices than were otherwise available on the formally advertised portion of the procurement: and, if so, the propriety of such awards; and third, whether the "floating set-aside" principal was legally authorized.

The Comptroller General answered the three questions as follows:

On the first question, which was whether or not partial set-asides were legal, the Comptroller General said that the "Congress, by enacting section 15 of the small business act, has authorized the negotiation of partial set-asides for small business subsequent to the unrestricted formally advertised portion of a procurement." Hence, he confirmed his previous decisions and held that partial set-asides were legally authorized by the congress.

To the second question, the Comptroller General devoted 8 pages of his opinion. It is difficult to concisely brief that much material and not run afoul of possible different interpretations which some of you may have already made. So, please forgive me for slight differences which may be occasioned only by my efforts to be brief.

The second question was whether the specific set-asides in issue were awarded at prices higher than otherwise available, and, if so, the propriety of such awards.

Basically the Comptroller General held that the formula being used by DPSC in determining set-aside award prices was in accordance with past Comptroller General decisions and in conformity with authority granted to DPSC by the department

of Defense. He said, "we do not object to the formula...so long as the total cost... would not exceed what it would have been absent a set-aside." However, although he did not object to the formula used, in this case he found that the specific awards were not computed in strict accordance with the formula and that "the price at which awards were made... is in excess of the price agreed to be paid," ...on the nonset-aside portion, and, in his opinion a downward adjustment in price with... the two concerns awarded the set-aside "would be appropriate." In other words, he did not question the formula for determining set-aside prices but he did question the propriety of the prices in that particular instance because he felt that the formula had technically not been properly applied.

It is unlikely that the same factual situation will again occur under the new set-aside procedures now being used by the defense petroleum supply center.

The third question you will recall was whether the "floating set-aside" principle was legally authorized. On that third question, the Comptroller General said that the "floating set-aside" violated the rules of formal advertisement in that it did not define, with sufficient certainty, the quantities available under each item for formal competitive bidding. Further, the Comptroller felt that DPSC had used the "floating set-aside" long enough to have acquired needed information on where and how large to make specific set-asides on an item by item basis.

As a result, the DPSC now uses an entirely different structure in designating set-asides. We now designate a certain quantity of various items as set-aside for small business. Hence on each item, the nonrestricted portion and the set-aside, or restricted, protion are fixed at the time the solicitation is forwarded to industry.

You will recall that our jet fuel solicitation each six months had been running in the neighborhood of 40 to 44 million barrels and that approximately 4 to 6 million barrels was set-aside. Actual awards to small business under the set-aside had been approximately 4 to 5 million barrels. And the total of the nonrestricted and set-aside awards to small business was approximately 9 to 10 million barrels.

It is difficult to compare results under the new set-aside procedures with results under the old floating set-aside because our procurement requirements for jet fuel have increased and are now approximately 50 to 55 million barrels each six month. Under the new procedures we have found it necessary to increase the total quantity set-aside for small business from approximately 6 million to 11 million barrels. Of the 11 million barrel set-aside, small business has accepted set-aside awards of approximately 8 million. This is a considerable increase over the 4 to 5 million awarded under the former floating set-aside. However, this increase reflects only a change in the pattern of awards and not an actual increase in overall awards to small business because the total of all jet fuel awards to small business remains at 9 to 10 million barrels. The pattern has changed in that the amount awarded on the nonset-aside portion has decreased and the amount awarded on the set-aside portion has increased a like amount with the result that the total awards of jet fuel to small business have remained essentially the same.

Notwithstanding that it has been necessary to increase the quantity set

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aside to retain the same proportion of awards to small business, and, notwithstanding that the new procedure has placed an additional administrative workload on DPSC, all present indications are that the general purpose and intent of the small business act are being as well carried out under the new procedure as was originally successfully developed under the floating set-aside procedure.

IMPACT ON CONTRACT TERMS

The second item I would like to discuss is the impact of the terms of our contracts upon industry.

You are familiar with the impact which government specifications have on the type and quality of commercial product and on industry standards in general. Government specifications in time tend to become industry standards. For the most part, this has been good for the industry when considered collectively. However, with the passage of time, individual companies within the industry have found it advisable to specifically interest themselves in the continuing development of government specifications.

The point I wish to make is that what is true of government specifications is, or should, also be true of government's contract terms. We must, of course, recognize that many of our contract terms are not within your and my province to amend. Those clauses which are required by statute and executive order are essentially sacrosanct and must be included in our contracts whether or not we like them or need them. There are, however, a number of clauses which are within our authority to amend: such as those concerning delivery, inspection, acceptance and invoicing.

About five years ago, we undertook a careful study of our supply contract general provisions. The revised provisions were incorporated into a new form designated, MPSA form 77. Our plan has been to revise this form each year. To date, we have been successful in doing so.

From what I hear, the industry is accepting, as its standards, some of the terms expressed in our government contracts. I think this trend will continue because our contracts touch nearly everyone in the industry and, hence, become common ground concepts within industry. Basically, this is good. However, although these concepts can be adjusted fairly easily in their early stages: time will make them ever more difficult to amend.

I am suggesting that you and your industry have a long term stake in our contract terms. I'm sure each of you know of marketing practices to which your company is now committed that you would gladly scrap. I've even heard some of you say you would like to hang first, and then try, the fellow who came up with the idea of credit cards.

Yet, the same thing can be happening with respect to the concepts embodied in our contract general provisions. Tanker deliveries provide a case in point. Our contracts provide that, on delivery F.O.B. a tanker, the title will pass at the ship's permanent hose connection but that measurement for quantity will be

at the suppliers' shore tanks and that inspection may be at still another point. In other words, "delivery" involves three different locations and three different points in time. What happens if there is a pipeline break between the shore tank and the ship's permanent hose connection? Could we, as a practical matter, designate one point for acceptance, measurement and passage of title? If we can, should we?

These questions and many, many others are involved in our contract general provisions. The answers we adopt have a long range impact on the industry. How can you and we get at the problem?

My suggestion is that you or members of your companies carefully and periodically review our contract terms and, from time to time, forward to us your comments and recommendations. I cannot guarantee that we will adopt any of your recommendations. It is even probable that industry comments, on any given concept, will vary from all black to all white. Naturally, we intend to adopt only that which is in the best interests of the government. However, there is a large area of common interest, and, the ideas you express on one subject may plant the seed of solution to that problem or to a problem on another subject. Without an expression of industry opinion we navigate to some extent in the dark.

In any event, I want you to understand that the Defense Petroleum Supply Center encourages industry comments on our contract provisions and that all comments will be carefully considered. One note of caution: the time to comment is before or after you submit a bid. We frown on comments submitted with your bids, and, as many of you may have regretfully learned, we are required to reject such bids as nonresponsive.

CHAPTER V

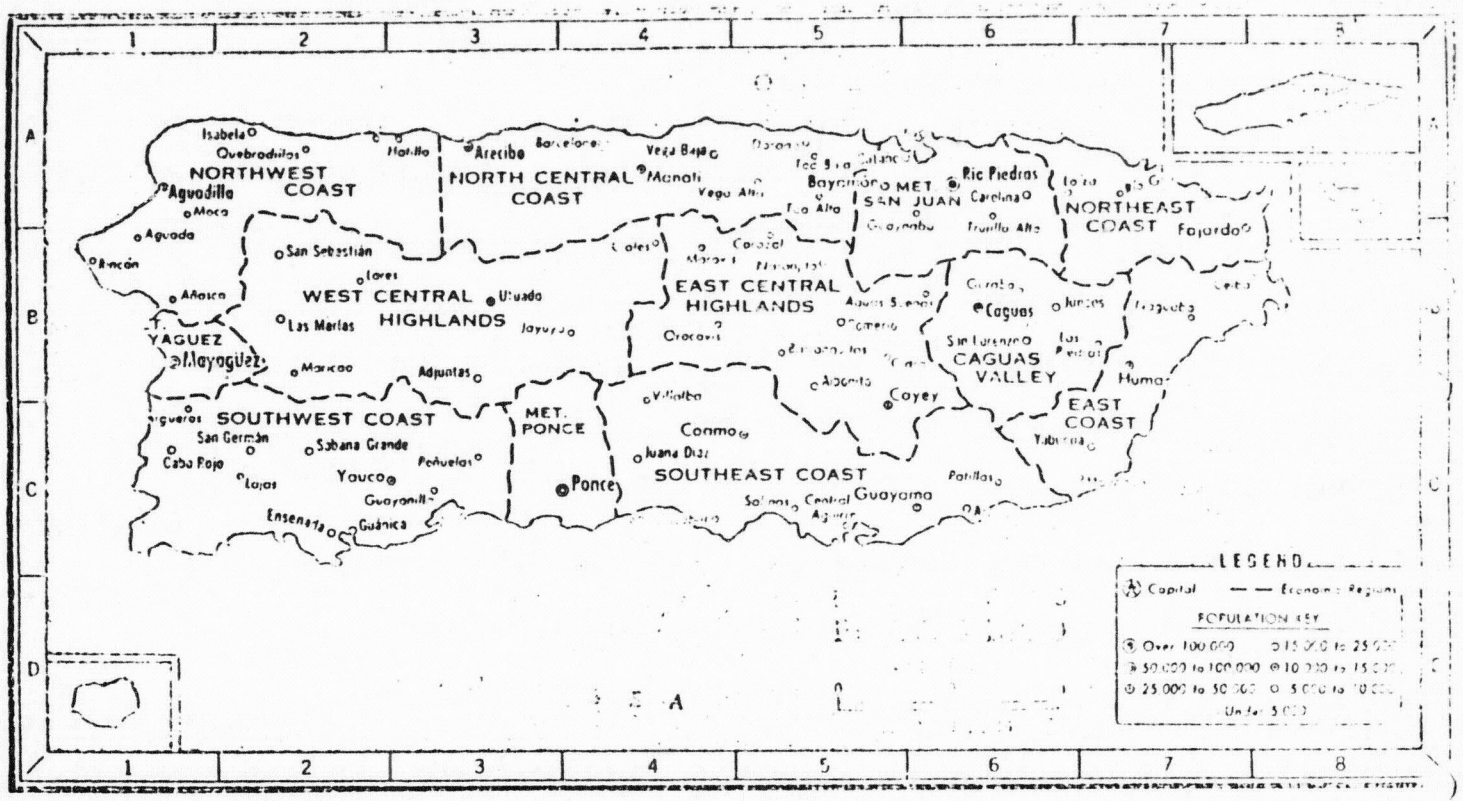
E 1505

ENGINEERING PLANNING

Engineering planning has been directed toward a practical compromise between a standard refinery and refinery designed to produce a maximum of petrochemical products for which there is little or no present market. The compromise results in a core plant to produce petrochemical feed stocks at the maximum rate they can be marketed. Further, however, is the key that this plant must be designed so that additional petrochemicals can be withdrawn in the future and that the company is committed to providing these additional petrochemicals or feed stocks.

Two studies and an addendum to the second study have been made by the Universal Oil Products Company for the proposed core plant. The plant covered by the second study with addendum produces approximately 18% of the dollar sales volume in petrochemicals. By adding a sulfur recovery unit and a tetraethyl lead antiknock additive plant, the petrochemical sales will increase to approximately 20%.

The study covers a 60,000 bbl/day refinery designed to produce a maximum practical quantity of petrochemical raw materials and intermediates. It includes capital and operating cost estimates, manpower requirements, process description, yields, estimated net operating income, and a site survey.



LEGEND

Capital — — Economic Region

POPULATION KEY

- Over 100,000
- 50,000 to 100,000
- 25,000 to 50,000
- 15,000 to 25,000
- 10,000 to 15,000
- 5,000 to 10,000
- Under 5,000

ECONOMIC REGIONS

(14 Regions)

Name of region followed by population in thousands, to nearest thousand, then location on map

Caguas Valley, 164	B 6
East Central Highlands 206	B 4
East Coast, 106	C 7
Met. Mayaguez, 87	B 1
Met. Ponce, 127	C 3
Met. San Juan, 509	A 5
North Central Coast, 213	A 3
Northeast Coast, 73	A 7
Northwest Coast, 198	A 2
Southeast Coast, 171	C 4
Southwest Coast, 130	C 2
West Central Highlands, 187	B 3
Vieques Island, 9	A 8
Culebra Island, 1	A 8

Total PUERTO RICO 2,229

CITIES

Name of city followed by population in thousands, to nearest thousand, then location on map

Adjuntas, 5	B 3
Aguada, 3	B 1
Aguadilla, 18	A 1
Aguas Buenas, 3	B 6
Aibonito, 5	B 5
Aguasco, 3	B 1
Arecibo, 29	A 3
Arroyo, 5	C 6
Barceloneta, 1	A 4
Barranquitas, 4	B 5
Bayamon, 20	A 5
Cabo Rojo, [illegible]	C 1
Caguas, 34	B 6
Camuy, 7	A 2
Carolina, 5	A 6
Catano, 9	A 6
Cayey, 16	B 5
Ceiba, 1	B 8
Central Aguirre, 3	C 5
Ciales, 3	B 4
Cidra, 3	B 5
Coamo, 12	C [illegible]
Comerio, 5	[illegible]
Corozal, 7	[illegible]
Culebra, 1	A 8
Dorado, 3	A 5
Ensenada, 5	C 2
Fajardo, 15	B 7
Guanica, 5	C 2
Guayama, 13	C 6
Guayanilla, 3	C 3
Guaynabo, 2	A 6
Gurabo, 4	B 6
Hatillo, 2	A 3
Hormigueros, 1	C 1
Humacao, 11	B 7
Isabela, 7	A 2
Juana Diaz, 5	C 4
Juncos, 8	B 6
Lajas, 1	C 2
[illegible]ares, 4	B 2
Las Marias, 5	B 2
Las Piedras, 3	B 7
Loiza, 3	A 6
Luquillo, 2	A 7
Manati, 10	A 4
Maricao, 1	B 2
Maunabo, 1	C 7
Mayaguez, 59	B 1
Moca, 1	A 1
Morovis, 2	B 4
Naguabo, 4	B 7
Naranjito, 2	B 5
Orocovis, 3	B 4
Patillas, 2	C 6
Penuelas, 2	C 3
Ponce, 99	C 4
Quebradillas, 2	A 2
Rincon, 1	B 1
Rio Grande, 3	A 7
Rio Piedras, 132	A 6
Sabana Grande, 5	C 2
Salinas, 4	C 5
San German, 9	C 2
San Juan, 225	A 6
San Lorenzo, 7	B 6
San Sebastian, 5	B 2
Santa Isabel, 1	C 8
Toa Alta, 1	A 5
Toa Baja, 1	A 5
Trujillo Alto, 1	A 6
Utuado, 10	B 3
Vega Alta, 3	A 5
Vega Baja, 5	A 4
Vieques, 3	A 8
Villalba, 1	B 4
Yabucoa, 5	C 7
Yauco, 10	C 3

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The details of the U.O.P. studies are included in Appendix B.

The general area of the site is shown in red on the map opposite. Further details of their site are shown on pages 45-47 of Appendix C.

# # #

CHAPTER VI

E 1508

ECONOMIC DATA AND FINANCING PLAN

The financial advisors to the PUERTO RICO OIL AND PETROCHEMICAL CO. have developed the following plan for financing the core plant.

This plan is an extension of the cost estimates from the study carried out by the UNIVERSAL OIL PRODUCTS CO., and includes additional financing for operating capital, including overhead and sales expenses, and contingencies to cover start-up expenses and unforseen delays in reaching a profitable rate of production. This contingency fund is approximately 20% more than the estimated costs shown in the UNIVERSAL OIL PRODUCTS study attached hereto, entitled PROCESSING AND ECONOMIC DATA FOR A PROPOSED PUERTO RICO REFINERY+SECTION 3+SUMMARY.

As shown in TABLE I, the total capital investment is estimated at $68,485,590 of which 80% is to be provided through Sinking Fund Debentures and 20% is to be provided through equity capital. In addition, the plant site is to be provided by the Commonwealth, and leased to the company. The area development is to be carried out by the Commonwealth.

To the estimated sum of $68,485,590, the company has added a sum of approximately 15% for operating capital, and unforseen expenses, bringing the total to $79,000,000.

The calculation in TABLE I of Net Operating Cost and Income is a proforma presentation, and flexibility exists under the tax laws of the Commonwealth tc permit full depreciation before any taxes are due. Other more favorable handling of debt burden co ıld be anticipated as the situation requires. However, the plan as shown is feasible, and should suffice.

The UNIVERSAL OIL PRODUCTS financial study is fully adequate in the opinion of the financial advisors to the company.

Stability is added to this plan by virtue of the marketing contract between the company and PHILLIPS PETROLEUM COMPANY, which assures the sales of the available product from the core plant.

This financial plan will be implemented through an S.E.C. Prospectus as soon as an oil import permit is issued to the company. The body of this Report, together with the financial plan, is substantially the material which will constitute the S.E.C. Prospectus.

Following is the report by the UNIVERSAL OIL PRODUCTS CO.

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE I

ESTIMATED NET OPERATING INCOME

Year	Product Value	Charge Value	Gross Profit	Operating Expenses	Net Profit	Sinking Fund Deposit	Debent. Interest [1]	Income Before Depreci.	Depreci.	Balance Before Taxes	Income Taxes	Income After Taxes	Earnings on Equity [2]	[3]
1	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	3,787.3	12,797.6	3,131.7	9,665.9	-	9,665.9	6,926.5	10,066.2
2	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	3,122.9	12,562.0	3,131.7	9,430.3	-	9,430.3	6,690.9	9,830.6
3	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,958.6	13,126.3	3,131.7	9,994.6	-	9,994.6	7,255.2	10,395.0
4	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,794.2	13,290.7	3,131.7	10,159.0	-	10,159.0	7,419.6	10,559.3
5	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,629.8	13,455.1	3,131.7	10,323.4	-	10,323.4	7,584.0	10,723.7
6	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,465.5	13,619.4	3,131.7	10,487.7	-	10,487.7	7,748.3	10,888.0
7	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,301.1	13,783.8	3,131.7	10,652.1	-	10,652.1	7,912.7	11,052.4
8	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	2,136.8	13,948.1	3,131.7	10,816.4	-	10,816.4	8,077.0	11,216.7
9	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,972.4	14,112.5	3,131.7	10,980.8	-	10,980.8	8,241.4	11,381.1
10	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,808.0	14,276.9	3,131.7	11,145.2	-	11,145.2	8,405.8	11,545.5
11	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,643.7	14,441.2	3,057.0	11,384.2	4,170.6	7,213.6	4,674.2	7,413.6
12	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,479.3	14,605.6	3,057.0	11,548.6	4,231.0	7,317.6	4,778.2	7,517.6
13	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,314.9	14,770.0	3,057.0	11,713.0	4,291.4	7,421.6	4,882.2	7,621.6
14	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	1,150.6	14,934.3	3,057.0	11,877.3	4,351.8	7,525.5	4,986.1	7,725.5
15	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	986.2	15,098.7	3,057.0	12,041.7	4,412.2	7,629.5	5,090.1	7,829.5
16	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	821.8	15,263.1	927.0	14,336.1	5,255.4	9,080.7	6,541.2	9,280.7
17	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	657.5	15,427.4	927.0	14,500.4	5,315.8	9,184.6	6,645.2	9,384.6
18	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	493.1	15,591.8	927.0	14,664.8	5,376.2	9,288.6	6,749.2	9,488.6
19	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	328.7	15,756.2	927.0	14,829.2	5,435.5	9,392.6	6,853.2	9,592.6
20	77,923.4	48,645.0	29,278.4	13,193.5	16,084.9	2,739.4	164.4	15,920.5	927.0	14,993.5	5,497.0	9,496.5	6,956.1	9,696.5

Notes:

(a) Total capital investment $68,645,590
20% Equity Capital $13,697,118
and Convertible Sinking Fund $54,788,472

Debentures, 6% interest, 20 years

(b) Yearly sinking fund, 1/20 of $54,788,472 = $2,739,424 paid at the end of each year out of income after taxes.

(c) Debenture interest, 6% on the unpaid debentures.

(d) Earnings on equity: Net income after payment of the yearly sinking fund.
Gross income after payment of the yearly sinking fund plus depreciation.

(e) Depreciable items: Process and offsites facilities and startup capital.

(f) Depreciation rate: Process Capital-straight line on 15 years life 10% salvage value.
Offsite Capital-straight line on 20 years life 10% salvage value.

(g) Income Tax: No income tax due for 1st ten years. Thereafter tax rate is 35.75% of taxable net income less $12,[illegible]

(h) All numbers in thousands.

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LONG TERM DEBT AND CAPITAL STOCK

PUERTO RICO OIL AND PETROCHEMICAL COMPANY

LONG TERM DEBT:

6% Sinking Fund Debentures* due December 31, 1977	... $34,000,000
6% Sinking Fund Debentures* due December 31, 1982	... $34,000,000

*With Warrents Attached

COMMON STOCK:

Public Offering @ $1.00*	... $11,000,000
	$79,000,000

*Authorized and Issued: 15,000,000 shares of which 11,000,000 constitutes the Public Offering, first in Puerto Rico, for 60 days, and then open to outside areas. The balance of 4,000,000 shares to management.

In setting forth this plan for financing, the continuation of current market conditions is assumed. In addition, a contingency fund of 20% has been provided for the unforseen.

The Commonwealth will provide the plant site and all area facilities which will be used jointly with others. The company will provide those facilities which it will use exclusively, including the off-shore tanker berths. The Commonwealth will lease the plant site to the company.

# # #

E 1513

the

CHEMICAL AND ALLIED PRODUCTS INDUSTRY IN PUERTO RICO

economic development administration · gpo · puerto rico

E 1514

DECEMBER 1961

This publication is issued by the Economic Development Administration, Commonwealth of Puerto Rico, San Juan, Puerto Rico. Copies may be obtained free upon request.

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INTRODUCTION

There are now over 80 chemical firms operating in Puerto Rico with 9 planning to start operations soon. This industry, which employs over 2,000 workers, is beginning to play an increasingly important role in the Island's industrial development. New chemical firms from the States, among them, Union Carbide, Parke-Davis, W. R. Grace, Baxter Laboratories, Colgate-Palmolive, Johnson & Johnson, have recently been attracted to the Island to set up their own operations; others, such as Morton Chemical, W. P. Fuller & Co., and Reichhold Chemicals, have formed joint ventures with local businessmen.

Some of the chemical products produced in Puerto Rico now are glycols, sulfuric acid, pharmaceuticals, paints, dental cream, etc. Products to be produced shortly include polyethylene, chlorine, caustic soda, and phthalic anhydride.

Last year Puerto Rico exported $19.5 million of chemical products to the United States and foreign countries. During fiscal year 1961, shipments to the mainland alone amounted to a record of $26 million.

Although the Island is importing record amounts of chemicals ($67.5 million last year), the rate of increase of exports during the last five years has been 3 times faster.

The future growth of the Industry looks quite promising. Not only are giant chemical firms being attracted to the Island, but in many cases after a short while they expand or start new operations.

Their success is the Island's best advertisement for it attests to the soundness of the profit opportunities the Commonwealth offers chemical manufacturers.

The following survey is designed to acquaint the reader with Puerto Rico's Chemical Industry, its potential development and the advantages the Commonwealth offers prospective manufacturers who select Puerto Rico as a plant location site.

THE CHEMICAL AND ALLIED PRODUCTS INDUSTRY IN PUERTO RICO

In 1950 there were 49 establishments in the chemical and allied products industry in Puerto Rico. These firms were small and locally owned, making pharmaceuticals, toilet preparations, solar salt and agricultural chemicals, primarily for the local market.

During the last decade, under the auspices of the Economic Development Administration, the industry has not only experienced tremendous growth but has developed to a point where it is playing an increasingly important role in the Island's industrial and agricultural development. The following table indicates some of the changes that have occurred in the industry during the last 10 years:

Chemical Industry in Puerto Rico
1950 and 1960

	1950	1960	Per Cent Increase
Number of establishments	49	73	49
Employees	1,268	1,921	52
Average hourly earnings	52¢	$1.19	129
Total Exports (millions)	$ 1.7	$19.5	1047
Total Imports (millions)	$24.0	$67.5	181

The Industry Today

The 1960 Census of Manufacturers, conducted by the Commonwealth Department of Labor, reported 73 establishments producing chemicals and allied products. During 1960, 6 new plants started operations, 4 have started operations so far this year, and 9 are pending establishment. Table I shows the composition of the industry by sectors with the employment and earnings in the 73 firms comprising the industry in October 1960.

Establishments, Employment, Hours, and Earnings in the Chemical and Allied Products Industry in Puerto Rico

October 1960

	Number of Establishments	Total Employment	Averages Production and Related Workers		
			Employment	Weekly Hours	Hourly Earnings
All Manufacturing Industries	1,958	81,740	69,624	36.6	$ .941
Chemicals and Allied Products	73	1,921	1,297	34.8	1.144
Industrial organic and inorganic chemicals; plastic and synthetic materials	9	714	445	41.3	1.534
Drugs	24	477	311	37.7	1.007
Soap, detergents, and cleaning preparations, perfumes, cosmetics, and other toilet preparations, paints, varnishes, lacquers, enamels and allied products	17	220	124	36.9	.818
Agricultural Chemicals	11	374	294	23.1	1.133
Miscelleneous Chemicals Products	12	136	123	30.0	.673

Source: Commonwealth of Puerto Rico, Department of Labor, Bureau of Labor Statistics
Census of Manufacturing Industries in Puerto Rico - October 1960

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The present applicable hourly minimum wage rates are as follows:*

Size and Location of Establishments

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About 48% of the chemical plants established in Puerto Rico employ fewer than 10 employees; 37% employ from 10-49 and 15% employ 50 or more workers as seen below:

Employees	Number of Establishments
Fewer than 10	35
10-49	27
50 or more	11
Total	73

Source: Census of Manufacturing Industries of Puerto Rico, October 1960
Puerto Rico Bureau of Labor Statistics

Fifty-eight per cent of the firms in this industry are concentrated in the San Juan metropolitan area; 4 per cent are located in the Ponce area, with the remaining plants scattered throughout the Island. Both the San Juan and Ponce areas have a petroleum refinery with the latter developing a substantial petrochemical complex. The attached map shows the geographic distribution of chemical plants in Puerto Rico.

Products

Puerto Rico's chemical firms now produce such diverse products as glycols, sulfuric acid, drugs, pharmaceuticals, paints, herbicides, dental cream, etc., both for the local and world market. The attached list of firms in the chemical and allied products industry in Puerto Rico, describing products produced and mainland affiliate, provides the reader with a general picture of the industry's scope.

GEOGRAPHIC DISTRIBUTION OF CHEMICAL PLANTS IN PUERTO RICO

- Oil Refineries
- Petrochemical and Other Basic Chemicals
- Pharmaceuticals
- Soap and Toilet Preparations
- Paints and Paint Products
- Agricultural Chemicals (Fertilizers, Insecticides, Herbicides Weed Killers)
- Fireworks
- Salt Works

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New Firms

In contrast with 1950, today nearly a third of the firms in the industry are affiliated with mainland firms. Among them are such chemical giants as Union Carbide, Parke-Davis, Baxter Laboratories, W. R. Grace, Sterling Drugs, Morton Chemicals, Johnson & Johnson and Colgate Palmolive; some of them having more than one operation on the Island.

Shipments

One immediate effect of these new additions to the industry has been an increase in the shipments of chemical products from the Island to the mainland and foreign countries.

Exports, which in 1950 were $1.7 million, have steadily increased and during fiscal 1960 reached a record, $19.5 million. This represents a ten-fold increase over 1950 shipments and an increase of 21% over the previous year total.

All sectors of the industry showed substantial increases of shipments over the previous year. Drugs and basic chemicals comprised 58% of the total.

Of significance also, is the fact that Puerto Rican exports of chemical products to foreign countries during fiscal year 1960 were valued at $4 million, nearly a five-fold increase over 1959 exports. Ethylene glycol shipments accounted for $3 million of this total.

Attached Tables II and III provide a more detailed presentation of the dramatic increase of 1960 Puerto Rican chemical exports over the previous year figures.

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Table II

Shipments from Puerto Rico to the United States
of Chemical and Allied Products

Fiscal Years 1959 and 1960

Product	1959	1960
Medical and pharmaceutical preparations	$3,822,904	$ 4,673,490
Alcohols, including glycols	17,514	8,517,149
Industrial chemicals, n.e.c.	1,300	1,300
Soap and toilet preparations	164,034	198,473
Chemical and related products, n.e.c.	1,513,351	2,223,507
TOTAL	$5,519,103	$15,613,919

Table III

Exports of Chemicals and Related Products
From Puerto Rico to Foreign Countries

Fiscal Years 1959 and 1960

Product	1959	1960
Coal tar and other cyclic acids	--	$ 825
Medicinal and pharmaceutical preparations	$445,030	620,147
Chemical specialties	73,915	101,109
Industrial chemicals (exclusive of medical chemicals, U.S.P. and H.F.)	8,296	3,027,835
Pigments, paints, varnishes and related materials	3,369	107,498
Fertilizers and fertilizer materials	70,450	45,866
Explosives	1,000	700
Soap and toilet preparations	36,228	28,811
TOTAL	$638,288	$3,932,791

Source: External Trade Statistics, Fiscal Year 1960
Puerto Rico Planning Board

Over 85% of Puerto Rico's external chemical trade is with the United States. The following table shows trade statistics between these two areas. Note below that shipments to the United States have tripled in the last five years and have been rising at a much faster rate than imports:

Chemical and Allied Products Trade
United States and Puerto Rico

Calendar Years 1955-1960

	P. R. Shipments to U. S.	Index (1955=100)	U. S. Shipments to P. R.	Index (1955=100)
1960	$18,145,240	345	$59,207,514	145
1959	9,620,483	182	58,241,209	143
1958	6,701,420	127	51,638,304	126
1957	6,986,057	132	48,552,491	119
1956	5,842,797	111	45,149,254	110
1955	5,272,782	100	40,863,265	100

Source: Report F T 800
United States Trade with Puerto Rico
U. S. Department of Commerce

Local Consumption

Increased economic activity on the Island has generated a high rate of local consumption of chemical products. The local market for these products is estimated at over $90 million a year and increasing rapidly. During 1960, Puerto Rico imported from the United States and foreign countries a record $67.5 million of chemical products compared to 1959's imports of $59.6 million; an increase of some 13% (see Table IV).

Shipments of Chemicals and Related Products From The United States and Foreign Countries to Puerto Rico

Products	United States 1959	United States 1960	Foreign Countries 1959	Foreign Countries 1960
Coal-tar and other cyclic chemical products	$ 554,473	$ 731,596	$ 11,796	$ 3,819
Medicinal and pharmaceutical preparations	12,194,738	11,626,821	18,490	56,423
Chemical specialties	22,899,230	27,226,312	--	--
Industrial chemicals (exclussive of medicinal chemicals, U. S. P. and N. F.)	2,557,505	2,729,666	2,587,712	3,007,032
Pigments, paints, varnishes and related materials	6,792,213	7,708,372	8,928	17,649
Fertilizer and fertilizer materials	2,205,604	1,835,834	2,148,865	3,794,136
Explosives, blasting agents, fuses and blasting caps	80,428	170,170	127,086	111,477
Soaps and toilet preparations	7,015,022	8,131,833	364,249	383,798
Total for chemicals and related products	$54,299,213	$60,160,604	$5,267,126	$7,374,339

Source: External Trade Statistics, Fiscal Year 1960
Puerto Rico Planning Board
Bureau of Economics and Statistics

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It should be noted that presently the output of the chemical industry in Puerto Rico is primarily for internal consumption; therefore, although the figures given in Tables II and III on value of shipments to the United States and foreign countries serve as an indicator of growth in the chemical industry, they are not as representative of total output as in the case in some other industries. In 1958, 81% of local production went towards meeting local demand, compared with 77% in 1954, as seen in the following table:

Value of Shipments and Markets for
Chemical and Allied Products
(In Millions)

	1954	Percent of Market	1958	Percent of Market
Value of Shipment	$25.9	100.0	$29.9	100.0
Market for Shipment				
Puerto Rico	20.0	77.2	24.3	81.2
United States	5.7	22.0	5.2	17.3
Foreign Countries	.2	.8	.5	1.5

Source: Census of Manufactures, 1958
U. S. Department of Commerce

That a great part of increased production is consumed locally is of great significance to Puerto Rico for it indicates:

-- a maturing economy. Increased chemical consumption and production are recognized indices of a developing industrial economy.

-- the need for importing certain products will diminish. A classic example is offered by the effect the establishment of the Island's oil refineries had on many imports.

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-- a whole range of products may be forthcoming which will not only furnish raw materials and intermediates to existing local industry and consumers, but can also serve as a base for the establishment of additional industries in Puerto Rico.

-- chemical production and consumption have grown and will continue to grow in order to satisfy the increasing needs of the industrial and agricultural sectors of the economy.

Research and Development

The Puerto Rican chemical industry, just as in the mainland, is expected to grow with its research accomplishments. In Puerto Rico's particular case it means the greater development and utilization of:

1. raw materials available from local sources (sugar, molasses, bagasse, salt, silica sand, limestone, etc.)
2. locally produced chemicals, or
3. crude oil and its yields (petroleum refining-petrochemicals).

The Economic Development Administration, through its Department of Industrial Research, conducts studies and experiments for the purpose of developing and improving local materials that may be utilized by local chemical manufacturers..for example, studies are being made on the possibility of using bagasse, a sugar waste, to make furfural and ultimately nylon. In addition to sugar, other available local raw materials that offer possibilities of development are salt, silica sand and limestone. See attached chart for a picture of some of the products that can be derived from these materials.

POTENTIAL DEVELOPMENT AND USES OF SELECTED LOCAL RAW MATERIALS

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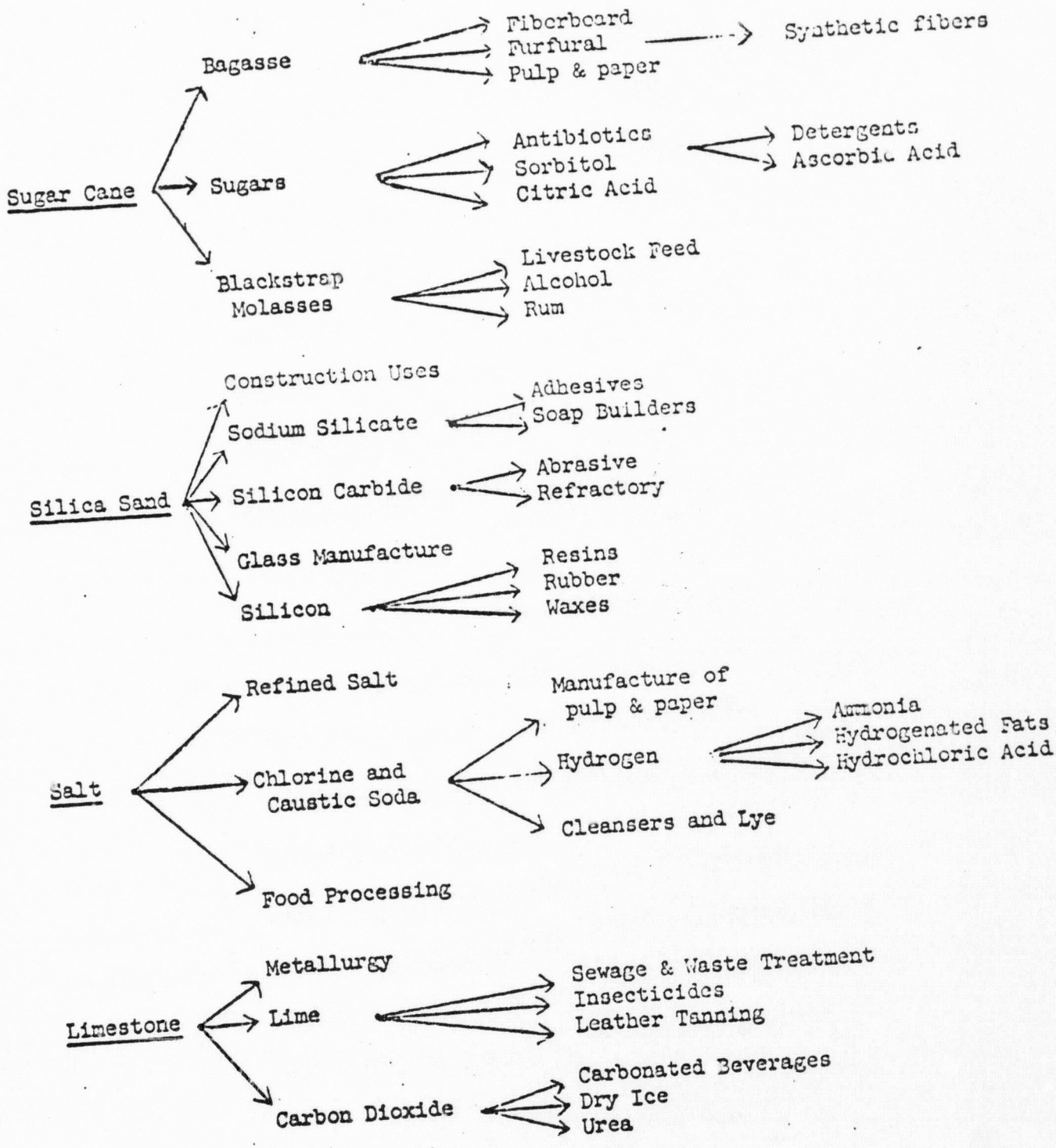

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Integration

Attached is a list of chemicals produced in Puerto Rico, many of which can serve as raw materials for other industries. Of particular interest are several projects which will be established shortly on the Island. They are: Union Carbide's $30 million polyethylene plant, a $2 million chlorine and caustic soda plant sponsored by local interest and the Morton Chemical Company, a $5 million expansion by Commonwealth Oil Refinery for the production of petro-naphthalene and benzene, and a $4 million phthalic anhydride plant proposed by Stepan Chemical Company.

When the above plants go on stream they will provide the basis for the manufacture of countless items not presently produced on the Island. For example, phthalic anhydride alone is a key chemical in the production of flexible plastic films, polyester resins, alkyd paints, surface coatings and dyestuffs.

By-products from Union Carbide's cracking naphtha operation that will ultimately produce polyethylene will include other unsaturated light hydro-carbons, such as propylene, butylene and butadiene, as well as heavier unsaturated aliphatics and aromatics. These by-products offer opportunity for further upgrading to commercial petrochemicals.

Petrochemical Development

Another area of promising significance to the chemical industry and the Puerto Rican economy in general is the use of crude oil as a raw material. In many cases, because of its proximity to oil rich Venezuela - 550 miles away -, and subsequent attractive transportation costs, it is also economically feasible to import nahptha and other petroleum derivatives. The fact that Puerto Rico already has two petroleum refineries lays the basis for an expanding petrochemical industry.

There are several reasons why great importance is attached to the need for an expanding petrochemical industry.

1. A local petrochemical industry could substantially compensate for the Island's lack of indigenous raw materials.
2. The industry affords permanent employment at relatively high wages.
3. The industry offers predominately male employment; an offset to the fact that new employment opportunities generated by our development program to date have been largely female jobs (60%).
4. Because of the magnitude of petrochemicals projects, these generate a substantial volume of construction employment and income.

Presently the Island's refineries are using the basic raw material, crude oil, to produce the familiar products: gasoline, kerosene, fuel oil, butane, propane gas and diesel oil. In addition, they yield or are capable of yielding other gases and liquid fractions such as hydrogen, methane, ethane, propane, ethylene, propylene, butylenes, butanes, and benzene.

Given the current and likely future state of technology, engineers and other experts anticipate that these various end-products, many of which will be suitable for manufacture in Puerto Rico. Methane, for example, can be converted into hydrogen, and this in successive stages into nitric acid, ammonium nitrate, urea, and ultimately fertilizer and other products. Methane also yields methanol which, via formaldehyde, yields plastics. Ethylene can be converted into any number of products and ultimately into plastics, synthetic rubber, synthetic fibers, detergents and explosives. The naphthenes yield an interesting group of products of which the most promising for the Island are nylon, synthetic rubber, plastics, paints, insecticides and synthetic fibers.

While there is a tremendous number of possibilities from the utilization of crude oil, refinery gases and liquid fractions, some of the above end-products if produced in Puerto Rico offer a high degree of comparative advantage. Puerto Rico's main economic resource is an ample labor force of high productivity which when coupled with existing reasonable wage rates results in low labor cost per efficiency unit of labor. It is clear that those products which require the greatest amount of labor are likely to show greatest advantage for a Puerto Rican location. Synthetic fibers whose labor requirements are relatively high is a good example of a potentially profitable operation for the Island. This observation was confirmed by a study of location factors in synthetic fiber production conducted at M. I. T. which selected Puerto Rico as a prime location site for a synthetic fiber plant.*

Urea is a specialty fertilizer for high value crop, and can be used as an industrial raw material and also for cattle feed; all of which can find ready markets in Puerto Rico. For example, industrial grade urea goes into the manufacture of formaldehyde resins and plastics used in making high grade plywood for the furniture and construction industries (two of the Island's biggest). Urea resins also go into the manufacture of plastic kitchenware and find various applications as well in the textile, paper and pharmaceutical industries.

These are only a few of many possible considerations. Generally speaking, other operations which gain exceptionally from Puerto Rico's advantages of low labor costs, high productivity and tax incentives are high profit and high value-added products.

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* Joseph Airov - "The Location of the Synthetic Fiber Industry"
Massachusetts Institute of Technology - 1959

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Production for Export

Another basis for the expected growth of the Commonwealth's chemical industry is the fact that Puerto Rico has developed as a site for chemical production for export markets. In the last few years, more and more U. S. chemical manufacturers have selected Puerto Rico as a base for operation to serve primarily the U. S. market. Exports to the U. S. and foreign countries which have been growing quite rapidly will be boosted substantially when Union Carbide's, Stepan's, Colgate Palmolive's and Johnson & Johnson's plants begin operations. All of the foregoing firms have acknowledged their intent to serve outside markets from Puerto Rico. In view of the many new advantages Puerto Rico offers chemical manufactuers, it is expected that other giant chemical U. S. firms will emulate the above firms' actions.

The Puerto Rican chemical industry as will be observed further on in this study is not a single entity but rather a heterogeneous one, which thrives on change. This is evidenced by the developments in the industry that followed the establishment of the Island's two oil refineries. It is expected, therefore, that the development of new products whether they originate from greater utilization of local raw materials, locally produced chemicals or crude oil will profoundly affect the profile of the industry. At the same time, by generating its own growth, it will aid the economics of other industries as well as Puerto Rico's over all economic development.

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INDUSTRY BY SECTORS

Drugs and Pharmaceutical Preparations

The Island's 28 drug and pharmaceutical manufacturers comprise about a third of the firms in the chemical industry. During recent years many outstanding names in the drug industry have established plants in Puerto Rico. Among them are: Sterling Drugs Inc., Baxter Laboratories and Parke Davis & Co. The latter two, established in 1958 and 1960 respectively, have since expanded their operations. In addition five other drug plants will start operations soon. See attached list of manufacturers of drugs and medicines in Puerto Rico.

Products

The Island's drug firms produce such products as intramuscular iron complex, intravenous solutions, hormones, vitamins, cough syrup, antibiotics, synthetic plasma, pharmaceutical active ingredients, etc.

Location

Plants producing drugs and medicines are located in ten of the Island's 76 towns. The industry, however, is concentrated in the San Juan metropolitan area, which accounts for over two-thirds of Puerto Rico's pharmaceutical preparation plants.

Labor

Local drug manufacturers employ approximately 500 workers, of which 40% are women. Average hourly earnings are $1.01, average weekly hours are 37.7 and average weekly earnings are $37.96.

The present applicable hourly minimum wage rates are as follows:*

Hormones, antibiotics and adrenalin	$1.00
Drugs, medicines, bay oil, aromatic alcohol	.77

A survey of fringe benefits in 15 plants included in this classification revealed that paid vacations of 2 weeks were granted by 8 plants, 3 weeks by one, 15 days by one, and from 1-3, depending upon length of service, for another firm; paid sick leave of 2 weeks by one firm; interest free loans with limits ranging from $50 to $100 are made by four firms; and annual bonuses are paid by four plants.

Shipments

During 1960, exports of pharmaceutical products produced in Puerto Rico were valued at $5.3 million or 27% of total chemical and allied products shipments. Exports to the United States for the first 7 months of fiscal year 1961 are valued at $4.4 million and represent an increase of 56% over the corresponding period of the previous year.

The following table shows comparative import and export drug data for the last 2 years:

	Puerto Rico Imports		Puerto Rico Exports	
	1959	1960	1959	1960
United States	$12,194,738	$11,626,821	$3,822,904	$4,673,490
Foreign Countries	18,490	56,428	445,030	620,147
TOTAL	$12,213,228	$11,683,249	$4,267,934	$5,293,637

Total imports to Puerto Rico of drugs and medicinal compounds from the United States and foreign countries have been decreasing steadily; in 1958 imports totaled $14.4 million, during 1959 $12.2 million and in 1960 they

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* Subject to 15% increase-November 3, 1961.

amounted to $11.7 million. This indicates that local drug manufacturers are not only increasing exports but are slowly beginning to capture more of the import market.

A bright future is envisioned for the Island's pharmaceutical firms producing not only for the export but also for the local market. This optimistic view is based mainly on the fact that rising consumer incomes plus an increasingly larger proportion of very young and older people, which in both cases require an above-average amount of medical care, will augment the local demand for drugs.

Successful Operations

The experiences of the following two U. S. pharmaceutical firms with their operations in Puerto Rico attests to the opportunities the Island offers the industry.

Parke-Davis first appeared on the Island in 1960 with a pilot operation employing 30 persons. It occupied a 45,000 sq. ft. plant in Carolina producing kapseals. Initial investment in machinery and equipment totaled $450,000. Early this year Parke-Davis expanded its plant 40,000 sq. ft. and invested an additional $982,000 to produce steri-vial and ampoules. This expansion will increase employment to 135 workers.

Baxter Laboratories started operations on the Island in 1958. It employed 70 persons producing pharmaceuticals in a 13,000 sq. ft. plant in Hato Rey. Investment in equipment and machinery totaled $100,000. The following year Baxter expanded its plant space by 11,000 sq. ft. and employed an additional 20 workers. Recently, Baxter announced it will open a new plant in Jayuya producing expendable administration sets (intravenous solutions) employing 45 workers.

One of Puerto Rico's largest drug plants, the Western Fher Laboratories, was inaugurated in Ponce recently. This firm, which operates under license from Foeringer Sohn of Germany, is the first Puerto Rican chemical plant affiliated with foreign interests. This move will probably be followed by other European firms also interected in producing for the United States and Latin American markets.

Advantages

The rapid growth and development of Puerto Rico's pharmaceuticals industry stem from the many advantages the Commonwealth offers the industry. For example:

1. Drug firms are able to recruit personnel from a vast labor pool with an average wage rate below that of mainland drug manufacturers.
2. Also available are competent pharmacists and chemical technicians, graduates from the Island's universities.
3. Since pharmaceuticals made in Puerto Rico for the local market, for the U. S. or exclusively for export must comply with U. S. Food and Drug Administration regulations, they enjoy the quality reputation associated with products ruled by these regulations. They also bear the "Made in U. S. A." marking.
4. Puerto Rico is part of the U. S. customs area so that shipments to the mainland are not subject to any duties.
5. Puerto Rico's tax exemption program is particularly beneficial to pharmaceutical companies where substantial sums spent on research and production to gain a unique position must be amortized quickly because of the high obsolescence rate of products in the industry.

Petroleum Refining, Petrochemicals and Other Basic Chemicals Refining

Puerto Rico has two oil refineries. The Commonwealth Oil Refining Company at Guayanilla Bay employs 823 workers and has a daily throughput capacity of 75,000 barrels of crude oil. The Caribbean Refining Company in Cataño has a daily capacity of 14,600 barrels. Both refineries began to process crude oil in 1955.

Presently, the refineries principal products are: fuel oil, kerosene, butane, propane gas, regular high octane gasoline, aviation gasoline, LPG and diesel oil. Both refineries sell substantial amounts of fuel to the Water Resources Authority, which provides the Island's electric service, and LPG to local distributors. The Commonwealth Oil Refining Co. (CORCO) also supplies by-products to Union Carbide. CORCO has already announced plans to enter the petrochemical field in the near future.

The attached chart shows the present capacities and types of processes used in Puerto Rico's oil refineries.

Petrochemicals and Other Basic Chemicals

The petrochemical industry in Puerto Rico is the most rapidly developing segment of the Puerto Rican chemical industry and also the most promising.

Manufacturers of petrochemicals and other basic chemicals account for just 12% of the number of establishments in the industry, yet employs over 700 workers or more than 37% of the industry's employment. Most of these plants are located in the Ponce area close to the Commonwealth Oil Refinery, which supplies them with some raw materials. A substantial petrochemical complex is beginning to take form in this vicinity. See attached chart for a description of the plants in this area with their products. Stepan's phthalic anhydride plant and Morton's chlorine and caustic soda plant will also be built in this area.

PUERTO RICAN OIL REFINERIES, THEIR CAPACITIES, AND TYPES OF PROCESSING*

	Crude Capacity BPCD	Crude Capacity BPSD	Charge-Barrels Per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed
Caribbean Refining Co. San Juan	14,500	15,200	10,000	---	8,500 2/	2,400	---		
Commonwealth Oil Refining Co., Inc. Guayanilla Bay	75,000	82,000	68,996	20,000 1/	26,600 3/	26,800	7,454 4/	7,500 5/	Mid-di
							7,454	7,454 6/	SR Naph
TOTAL	89,600	97,200	78,996	20,000	35,000	29,200	7,454	14,954	

	Production-Barrels Per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Caribbean Refining Co. San Juan	---	1,300 8/	---	---	---
Commonwealth Oil Refining Co., Inc. Guayanilla Bay	1,425 7/	1,605 8/	---	---	---
TOTAL	1,425	2,905			

LEGEND:

Thermal Process:
1/ Visbreaking

Catalytic Cracking:
2/ Fluid
3/ Houdriflow

Catalytic Reforming:
4/ Houdriforming

Catalytic Hydrogen Treating:
5/ Unifining
6/ Houdry

Alkylation:
7/ Sulfuric acid

Polymerization:
8/ Catalytic

Feed:
(1) Midstream distillation
(2) Straight run naphtha

* As of January 1, 1961.

Source: Oil and Gas Journal - April 3, 1961

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THE GROWING PONCE PETRO-CHEMICAL CENTER

Ponce Chemicals Inc.
(Morton Chemicals)

Products: Chlorine, caustic soda, hydrogen

Union Carbide Caribe #2
(Union Carbide)

Product: High pressure polyethylene

Commonwealth Oil Refining Company

Products: Oil refining: Gasoline, kerosene, diesel oil, fuel oil, LPG.
Supplies Union Carbide with raw materials, and the P. R. W. R. A. with pitch.

Union Carbide Caribe #1
(Union Carbide)

Products: Glycols: monoethylene, diethylene, triethylene

Caribe Nitrogen Corp.
(W. R. Grace)

Products: Sulfuric acid, ammonium sulfate, and anhydrous ammonia

Stepan Chemicals
(Stepan Chemicals)

Product: Phthalic anhydride

Puerto Rico Water Resources Authority

Furnishes above chemical firms with electric energy needs.

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Some key chemicals now, or soon to be, produced in Puerto Rico are: Glycols, sulfuric acid, ammonia, chlorine, caustic soda, polyethylene and phthalic anhydride.

This is an increasingly important sector of the industry not only because of its capital-intensive nature (W. R. Grace's and Union Carbide's plants alone represent investments in excess of $50 million), but especially because of the new vistas that these products will open for Puerto Rico's industrial evolution.

The W. R. Grace $14 million Caribe Nitrogen plant in Guánica, with 200 workers, is the only ammonia, ammonium sulfate plant in Puerto Rico. It was built to make the Island more self-sufficient as a basic chemical producer for industry and agriculture. Its design capacity is 125 tons of ammonia and 350 tons of sulfuric acid daily, which can be combined to make over 400 tons daily of ammonium sulfate.

Union Carbide's $38 million plant in Peñuelas, with 340 workers, produces ethylene, diethylene and triethylene glycol primarily for export. In mid-1960 Union Carbide announced plans for the construction of a huge $30 million polyethylene plant to be built adjacent to its existing operation. This would make Union Carbide the largest single industrial investor on the Island. The plant's initial annual production capacity of 110 million pounds of high pressure polyethylene is said to be the largest initial production capacity of any single polyethylene plant in the world. Production will be geared to serve world markets. There is no question that local plastics fabricators will be able to benefit from this low-cost local supply of raw material especially when coupled with an abundant supply of both male and female labor at reasonable wages.

Puerto Rico's new caustic soda and chlorine plant, a joint venture with Puerto Rican and mainlanders sharing in opportunities, will open the way for the

manufacture of essential base materials for other industries. Chlorine for example, will find use in the production of other chemicals such as bleaches, antifreezes, solvents, insecticides, plastics, and refreigerants. Caustic soda will be used in chemical processing, in the manufacture of pulp and paper, textile processing and in soaps and cleaners.

Stepan Chemical has recently announced its plans to establish a $7 million phthalic anhydride plant in Puerto Rico. This will also open the way for many new manufacturing operations for the Island since phthalic anhydride is used in the manufacture of polyester resins, alkyd paints, surface coatings and dyestuffs.

Industrial chemicals exports totaled $11.5 million during fiscal year 1960 while total imports were valued at $32.9 million. Glycols account for almost all of the Island's exports of basic chemicals; $2.9 million of these shipments went to foreign countries.

Production of other products included in this classification such as organic and inorganic acids, industrial alchohol and compressed and liquified gases, which has also expanded tremendously during the last few years, is consumed almost entirely locally to meet the growing Puerto Rican demand for these products.

Soap and Toilet Preparations

This sector of the industry is also going through a period of marked change. Of the 13 firms included in this classification, 4 were established during the last 2 years and one is pending establishment.

For years, firms included in this classification produced bay rum, toilet waters, hair preparations, perfumes, and the like for the local market. However, during the last couple of years, many new plants affiliated with mainland firms have established on the Island producing washing soap, sanitary chemicals,

detergents, dental cream and baby powder. These manufacturers are beginning to capture more of the local market for these products and are now even exporting increasing amounts; $200,262 in 1959; $227,284 in 1960.

Earlier this year, Johnson & Johnson's plant to produce baby powder opened; soon Colgate-Palmolive will open its dental cream plant. The addition of these firms to the industry will not only mean increased diversity of products produced on the Island but also that export shipments should rise considerably in the near future.

Soap and toilet preparation imports last year were valued at $8.5 million, a 20.8% increase over 1959 shipments. Sales of these items in Puerto Rico should continue to expand since they are closely tied to personal income increases. Therefore, the Puerto Rican market proper offers opportunities because of its growth potential.

This industry is characterized by a high value added ratio because it requires a large labor force to package the materials and ready them for sale to the consumer market. The availability of semi-skilled labor at lower costs that on the Mainland are prime reasons why Puerto Rico should be considered as a plant location site for the manufacture of products included in this classification.

Miscellaneous Chemicals

Among the products produced in Puerto Rico included in this category are fertilizers, fungicides, paints and varnishes, insecticides, salt and fireworks. The 26 firms producing these products employ over 500 workers.

Fertilizers

Owing to soil conditions and the fact that Puerto Rico's agricultural economy is oriented toward crops that yield a high value per acre, the Island

consumes large quantities of commercial fertilizer for the production of sugar cane, tobacco, pineapples, coffee and vegetables. To supply this market several fertilizer mixing plants have been established in Puerto Rico (see attached list of fertilizer mixing plants in Puerto Rico). During 1960 these plants produced 208,300 short tons of mixed fertilizer, almost all of which went for local consumption. Puerto Rico imported $5.6 million worth of fertilizer mix during the same period.

Paints and Related Products

There are six firms in Puerto Rico producing paints and related products with two new high quality plants pending establishment. Three plants are affiliated to mainland concerns and three are locally owned (see attached list).

It is expected that once paint solvents and soybean oil are locally produced, additional impetus would be given to a considerable expansion in paint manufacture since two of the three major components of paint would then be locally available. Local paint manufactuers, who are now only supplying about 20% of the local market, will not only then be able to capture some of the market for externally produced paints and lacquers, imports of which last year were valued in nearly $8 million, but will also begin to seek new export markets.

Other Chemical Products

There are 7 firms in Puerto Rico producing herbicides, insecticides and weed killers mainly for the local market. These products are finding increasing use in Puerto Rico in tune with the Island's agricultural development. Last year imports of these products were valued in excess of $2.2 million.

Included in this classification are two small firms in San Sebastián producing fireworks for local festive occasions.

It is estimated that due to climatological conditions, local production of raw salt has been averaging 10,000 tons annually for the last 3 years, with solar salt production capacity of 30,000 tons annually. There are six firms producing raw or industrial salt, one of which, Ponce Salt Industries, produces both industrial and refined salt. This firm produces some 1.4 million pounds of refined salt monthly under such labels as Morton, Ivory, White Crystal.

While the above products included in the miscellaneous chemical classification are primarily for local consumption, exports to the United States and foreign countries last year reached a record, $2.5 million, compared to $1.7 million during 1959. During 1961, shipments to the United States were 32% greater than in 1960.

LOCATIONAL FACTORS

The Commonwealth in its efforts to assume the continued success of the chemical and allied products industry, so vital to Puerto Rico's industrialization program, is doing all within its power to attract qualified chemical manufacturers to the Island.

Following are some of the major reasons chemical manufacturers are selecting Puerto Rico as a plant location site, and some of the services offered by the Commonwealth to these firms.

Labor Availability

A substantial pool of trained labor is available to new chemical products manufacturers throughout the Island. The total labor force during fiscal 1961 averaged 641,750 workers, of whom 70,000 or 11 percent were unemployed and available for employment.

The Puerto Rican Employment Service will test and screen applicants for positions in the chemical and related industries. On-the-job training programs are also offered with EDA paying for instructors. Furthermore, EDA's Department of Industrial Services will assist new firms in sending supervisors and managerial trainees to plants on the mainland or in bringing technicians to the island for training managers and supervisors.

Competent pharmacists, engineers and chemical technicians, graduates from the Island's universities are readily available on the Island. Graduates for the last three years were as follows:

	1958	1959	1960
Chemical engineers	6	6	7
Bachelor in chemistry	n.a.	n.a.	42
Pharmacists	36	22	36

Reasonable Wage Rates

The minimum wages for the various divisions in the chemical industry as set by the Wage and Hour Division of the U. S. Department of Labor are as follows:

Classification	Rate	Effective Date
Agricultural Chemicals	1.15 F	November 3, 1961
Fertilizer Mixing	1.15 F	November 3, 1961
Industrial Inorganic Chemicals	1.05 1/2 F	December 5, 1961
Miscellaneous Chemical Products	1.09 F	December 5, 1961
Hormones, Antibiotics and Adrenalin	1.15 F	November 3, 1961
Drugs, Medicines, Bay Oil, Aromatic Alchol and Toilet Preparations	.88 1/2 F	December 5, 1961
Petroleum Refining	1.15 F	November 3, 1961
Pipeline Coating Tapes	1.15 F	November 3, 1961
Miscellaneous Petroleum Products	1.09 F	December 5, 1961

Because of the labor surplus, average wages in each division tend to remain close to the minimum.

The overall average hourly earnings in the chemical and allied products industry in Puerto Rico during 1960 was $1.14 compared to the mainland average of $2.53. The following table illustrates the comparative situation in this industry.

Hours and Earnings - Chemical & Allied Industry
United States and Puerto Rico
1960-1961

PUERTO RICO			UNITED STATES	
1960	1961		1960	1961
$ 1.14	$ 1.25	Average Hourly Earnings	$ 2.53	$ 2.58
34.8	37.6	Average Weekly hour per worker	41.2	41.3
$39.67	47.08	Average Weekly earnings	$104.24	106.55

Source: U. S. Department of Commerce - Survey of Current Business June 1961
Commonwealth of Puerto Rico - Department of Labor June 1961

The table below shows comparative average hourly earnings by sector of this industry in Puerto Rico and the United States as of October 1960:

	United States	Puerto Rico
Chemicals and Allied Products	$2.53	$1.14
Industrial organic chemicals	2.70	1.53
Industrial inorganic chemicals	2.53	
Drugs and Medicines	2.34	1.01
Soap, cleaning and polishing preparations	2.73	0.82
Paints, pigments, varnishes, lackers, and enamels	2.49	
Fertilizers	1.90	1.13
Vegetable and animal oils and fats	1.95	
Miscellaneous Chemical Products	2.73	0.67

Puerto Rico lends itself ideally to the production of high labor input products because of the abundance of skilled and semi-skilled labor at reasonable wage rates.

Transportation and Freight Rates

There is frequent, scheduled steamship and trailership service between Puerto Rico and the United States. Average transit time between New York and San Juan is 3 1/2 - 5 days. There is also regular, low-cost steamship service between Europe, Latin American and Asia. Sample rates for Puerto Rico to Atlantic Gulf Coast port shipments of chemical and allied products are as follows:

	Per Cu. Ft.	Per C.W.T.
Alcchol (butyl, denatured ethyl)	$0.33	--
Polyethylene products	0.43	$1.09
Bay rum	0.36	--
Chemicals, N.O.S.	0.77	1.92
Drugs N.O.S.	0.77	1.92
To Pacific Coast Ports:		
Chemicals, Drugs and Pharmaceuticals	0.95	2.28

If planned movements are to be substantial, lower rates can generally be obtained for commodities without specific rates at present.

There are five regular airlines giving cargo service between the Island and the Mainland; with New York only 3 1/2 hours away by jet. Hormones, antibiotics and adrenalin comprise the largest portion in terms of value of chemical shipments moving from Puerto Rico to the Mainland by air.

Below are representive air freight rates.

General Commodity Air Freight Rates from San Juan	Rate Per Pound Under 100	100 and over	3,300 and over
Miami	$0.15	$0.12	$0.10
Philadelphia	0.20	0.16	0.14
New York	0.20	0.16	0.14
Chicago	0.32	0.25	0.23

Water E 1549

The Aqueduct and Sewer Authority supplies water to the Island's industrial users. While the capacity of some of the aqueducts is large enough for industrial use, process water is largely obtained from rivers and wells.

The approximate average flow of Puerto Rico's major rivers is shown below:

River	Minimum Flow MM Gal/Day
Cibuco	25.8
Culebrinas	9.7 - 12.9
Blanco	9.7
Guanajibo	9.7
Loíza	75.0
Manatí	64.6
Arecibo	64.6
Añasco	64.6
Plata	38.8

Several large chemical operations in Puerto Rico use salt water for cooling, and most of the fresh water used for cooling is recirculated. Air cooling is practical in the southern coastal regions.

There is a wide variation in the degree of hardness of the Island's water depending on location. Underground water resources are ample in many areas and are well charted. Some large industrial users found it more economical to sink their own wells.

For large industrial users, water rates decline with quantity to a minimum rate of about 3.5¢ per cubic metter (10¢ per 100 cu.ft.).

Rates for sewer service are generally one-third of the water charge, and assistance is provided in the disposal of large volumes of industrial waste.

E 1550

Electricity and Fuel

Electric power in Puerto Rico is currently 88 per cent steam generated. Output was 2,206 million kilowatt-hours in 1960 with dependable capacity of 598,920 KW. The entire Island is connected by a well-developed high tension grid. The system provides dependable single and three phase 60 cycle alternating current at standard voltages. Rates are comparable to those in mainland areas which depend primarily on steam generating plants, such as New England and the Middle Atlantic States. The average cost per KWH for industrial use is 1.53 cents with some large industrial users paying as little as 1 cent.

Most manufacturers in Puerto Rico use oil for industrial process heating. The Island's two refineries provide fuel oils and a local source for petroleum products, including commercial LPG.

Raw Materials and other supplies and services

Aside from the locally produced chemicals (see attached list), other materials available locally are: solar salt, limestone, silica sand, clay, pure limestone, dolomitic limestone, sugar molasses, bagasse, gasoline, kerosene, fuel oil, refinery gases, liquified gases, bottles, jars, cans, corrugated shipping containers, folding and set-up boxes, boxes for pharmaceutical products, etc.

Local agents of major U. S. chemical suppliers maintain warehousing facilities to supply chemicals locally, many at mainland prices. There are trucking firms with tank cars for the movement of liquids and barges for transporting bulk shipments between ports in the Island.

Government Services to Chemical Manufactuers

One of the most important services offered by EDA to chemical companies is assistance in locating and acquiring a suitable plant site. The Puerto Rico

Industrial Development Company (PRIDCO) constructs for lease or sale multi-purpose building at rental rates ranging from 50¢ to 95¢ per square foot annually depending upon location and requirements. In certain cases PRIDCO constructs special buildings to meet individual requirements of a manufacturer.

Manufacturers who use local raw materials, can benefit from studies and experiments conducted by the Department of Industrial Research which develops new and improved methods of utilizing local materials, such as bagasse, molasses, etc.

U. S. Geological Survey maps cover all of Puerto Rico and the periodic census data on population, labor force, and markets in each municipality are supplemented by special surveys to aid in site selection.

In addition, the Department of Industrial Services provides assistance in plant lay-out; and the Government Development Bank for Puerto Rico makes available to chemical manufacturers, loans on land, buildings, machinery, and equipment.

Attractive Tax Incentives

Chemical manufactuers who decide to establish in Puerto Rico literally enjoy a "tax holiday" since federal tax laws do not apply in Puerto Rico and Commonwealth taxes may be waived for a period of up to ten years.

The Puerto Rico tax exemption law is of particular interest to the chemical industry where product obsolescence is fairly high and payout time is short, since it enables a manufacturer to reinvest earnings for plant expansion or product diversification at a rate roughtly twice that of the U. S. mainland where corporate taxes would have to be paid. Additional ten year grants are available for new plants and expansions under certain conditions.

The tax-exemption feature can be especially attractive to chemical companies which are introducing a new product likely to achieve high profitability. When a unique useful product has been developed and patent protection, raw material advantage, or company-restricted know-how promise to give it a period of superiority over competitive products, a company can take advantage of the tax exemption offered in Puerto Rico to retain the high earnings achieved during the early life of the product.

At the termination of the tax-exemption period, the manufacturer becomes taxable under the Puerto Rican tax laws on the same basis as nonexempt cases, but the maximum corporate tax rate is 38% and undepreciated assets may be depreciated with complete flexibility. A variety of attractive possibilities thus exist for the reinvestment in Puerto Rico of accumulated tax-exempt profits.

Good Geographic Position

U. S. manufacturers are increasingly finding that Puerto Rico is an ideal plant site because of its geographic location in relation to the growing Latin American market. Puerto Rico's geographic position permits local manufacturers to utilize crude chemicals or materials from Latin America for processing and shipment of the finished product to the States for sale, or vice versa. Also, not only is Venezuela only 550 miles away, but Puerto Rico is as close to Europe as the U. S. Eastern Seaboard is, and, of course, has a transportation advantage over the U. S. Gulf ports to Europe and South America.

For chemical companies wishing to distribute products to a number of foreign markets as well as the United States, it may be worthwhile to consider a location in the Foreign Trade Zone at Mayaguez in western Puerto Rico. Here, raw materials can be imported duty-free and processed or manufactured within

the Zone. Final products can then be shipped abroad without payment of duty. Manufacturers bringing products into the United States, Mainland or Puerto Rico from the Zone pay duty on the dutiable raw materials which went into the products. This feature is especially attractive to chemical companies who may wish to import organic intermediates (which have high U. S. duties) from foreign countries for processing for the U. S. and Latin American markets.

E 1554

SUMMARY

This report has attempted to provide the reader with a general picture of the chemical industry in Puerto Rico, its potential development, and the advantages the Commonwealth offers prospective chemical manufacturers who select Puerto Rico as a plant location site.

Described below are some of the salient characteristics of those products which, backed by past experience and economic considerations, have proven to be the most promising for successful manufacture on the Island.

We have also briefly noted some of the Island's main attractions to chemical manufacturers.

Classification	Economic Consideration
1. High profit items	Exemption from both federal and Commonwealth taxes permits chemical companies which are introducing a new product likely to achieve high profitability, to retain the high earnings achieved during the early life of the product.
2. High value-added products	Products which gain substantial value because of high labor input, whether from manufacturing or packaging for distribution, are able to benefit greatly from the Island's lower labor costs and high worker productivity.
3. Capital Intensive operations	Puerto Rico's tax advantages (income and property tax exemption, flexible and lower tax rates after tax exemption period expires) permits a short payout period which makes possible earlier distribution of earnings. It also enables chemical manufacturers to reinvest earnings for plant expansion or product diversification at a rate roughly twice that of mainland manufacturers where corporate and property taxes would have to be paid. Reinvestments are eligible for new tax exemption grants under certain conditions.

4. Products based on local raw materials

Puerto Rico's local raw materials, such as sugar, silica sand, salt limestone, etc., and basic chemicals already produced on the Island, provide a low- cost basis for the production of a multitude of other chemicals and allied products.
Petrochemical production, for example, benefits from a local supply of crude oil by-products from the Island's refineries; other petroleum derivatives can be economically supplied from nearby Venezuela.

FACTORS FAVORING MANUFACTURE OF CHEMICALS IN PUERTO RICO

1. Free access to the U. S. mainland market since Puerto Rico is within the U. S. Tariff System.

2. Tax exemption of Commonwealth taxes for a period of up to 10 years. In addition Federal Internal Revenue laws do not apply in Puerto Rico. Chemical manufacturers can also enjoy the privilege of flexible depreciation when their tax exemption grant expires.

3. Comparatively low labor costs and a large supply of semi-skilled and unskilled labor are available on the Island.

4. Wide variety of Government and community assistance and services to chemical manufacturers; including universities and government research laboratories.

5. Basic raw materials and services are readily available. Some of those not locally produced are available at mainland prices.

6. Location advantage to serve the Caribbean, South American and European markets, including opportunities offered by the Mayaguez Foreign Trade Zone and the local Puerto Rican market proper.

CASE STUDY

COMMONWEALTH OIL REFINING CO., INC.

- Operation and Products -

Commonwealth Oil Refining Co.'s facilities cover 112 acres and are situated at Guayanilla Bay, a protected deep water harbor fifteen miles west of Ponce. It employs 823 workers, 85 of which are continentals; the remainder are local personnel.

It is the 32nd largest U. S. petroleum refinery. Presently, it has a daily throughput capacity of 75,000 barrels which embraces two complete refinery units. One has a daily capacity of 30,000 barrels and the other has a daily capacity of 45,000 barrels.

Of the total Puerto Rican demand of approximately 53,000 barrels per day, Commonwealth Oil currently supplies approximately 65% or 35,000 barrels; Caribbean, the Island's other refinery, supplies about 11,000 barrels, the remaining amount is brought in by various importers.

Equipment

CORCO's equipment consist of: two crude oil atmospheric and vacuum distillation units, two catalytic reformers, two catalytic cracking and vapor recovery units, polymerization units, alkalization unit, acid plant, extraction plant, steam generating plants.

Products

Commonwealth Oil is currently producing: 115/145, 100/130 aviation gasolines, premium and regular gasolines, JP-4 aviation turbo fuel, Diesel oil, gas oil, No. 2 Heating oil, No. 4 Fuel oil, kerosene, No. 6 Fuel oil, pitch LPG, gas, special cycle oils.

Operating Scheme

The Venezuelan crude goes through atmospheric distillation. From there the streams go on to catalytic cracking. Cracked products are: cracked gasoline, heavy cycle oil that is blended into fuel oil and gases.

The gases go to a gas separation and gasoline stabilization plant where the light components are removed from the gasoline to reduce its vapor pressure to an acceptable value; at the same time the gases are separated into three principal streams. 1) C_4 and heavier, principally butane, butylenes, pentane and amylenes; 2) C_3 fraction consisting primarily of propane and propylene, with a small amount of lighter components. About 70% of the total propane and propylene of the cracking gases is obtained in this stream; most of the remainder goes into the next stream of lighter gases. 3) A light gas fraction consisting of ethane, ethylene, methane and hydrogen. This fraction contains about 30% of the total propane and propylene of the refinery gases.

Destination of Separated Gas Streams

The C_3 stream goes to catalytic polymerization; the C_4 stream goes to catalytic polymerization or to catalytic alkalization. Both of these processes produce aviation gasoline.

Before being fed to the polymerization reactor, the C_3 stream has to be cleaned of hydrogen sulfide, since the latter spoils the catalyst. The clean C_3 stream goes through the reactor where the propylene is consumed, but the propane goes through unchanged and emerges in the tail gases. This propane can be used for several alternate purposes, e.g., for refinery fuel, for the production of liquified propane (LPG) for commercial sales, or it can be used for the manufacture of ethylene by cracking.

Product Distribution

In total, about 50% of CORCO's production is consumed locally with the balance being shipped to the mainland by the purchasers of the products. A small amount is shipped to foreign markets.

Adjoining the refinery is the South Coast Steam Electric Generating Station of the Puerto Rico Water Resources Authority, completed in 1958, to which Commonwealth Oil supplies 3,000 barrels per day of low-cost high efficiency fuel. About 1,000 barrels per day of refinery gas is sold to Union Carbide's ethylene glycol plant, completed in 1959. It is due to supply additional quantities of the same feedstock when Caribe completes its 110-million lbs./year polyethylene plant at the same site.

Finance

Net sales in 1960 totaled $76.7 million, with a net income of $6.6 million. Sales during the first 6 months of 1961 are running 20% higher than the same period last year, net income has already passed the $6 million mark (see attached chart).

Commonwealth Oil which has fixed assets of $50 million and total assets of over $75 million, rank 481 in Fortune's Directory of the "500 Largest U. S. Industrial Corporations", and is listed as having the highest return on investment of all companies (43.4 per cent). The President has stated that this year's return would be about 28% when adjusted for equity dilution.

Tax Exemption

The refinery presently operates under two separate grants of tax exemption from the Puerto Rican Government. The first was the original grant which terminates December 31, 1966. This grant exempts 100 per cent of the income

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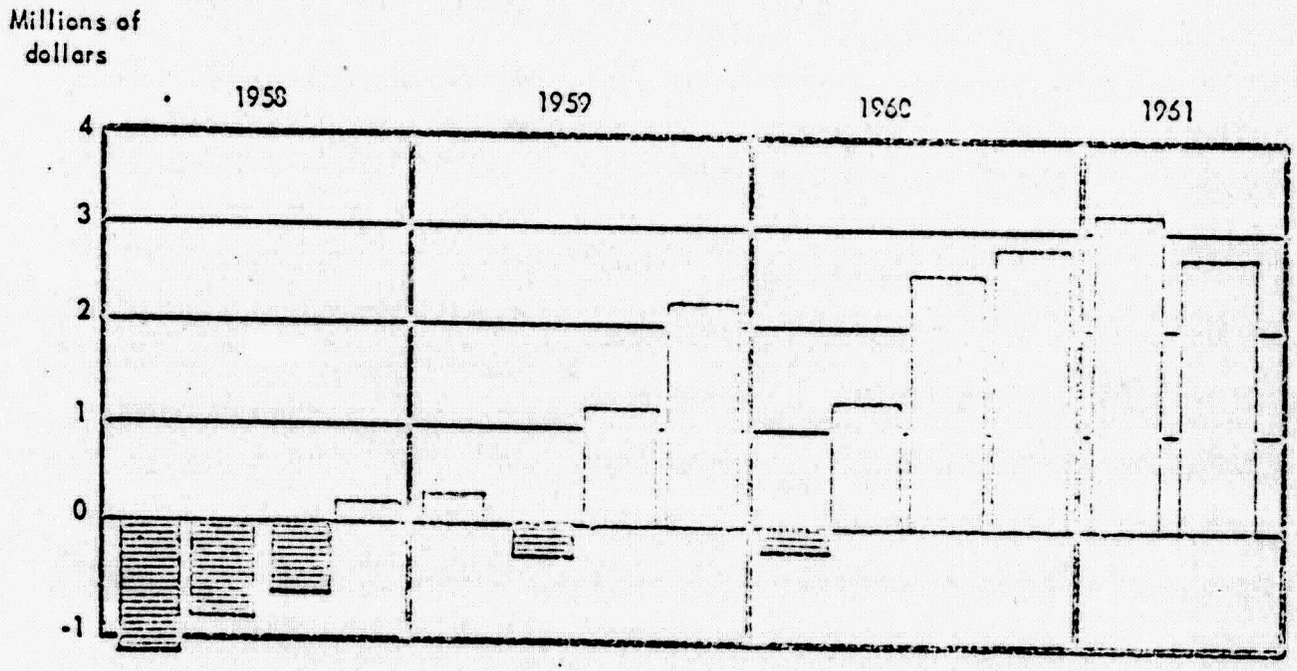
Commonwealth Oil Refining Company, Inc.

Net Profit (Loss) by Quarters



(000 omitted)

	1958	1959	1960	1961
1st Qtr.	(1,190)	235	(331)	3,275
2nd Qtr.	(973)	(362)	1,385	2,828
3rd Qtr.	(671)	1,028	2,619	
4th Qtr.	161	2,234	2,945	
Year	(2,673)	3,135	6,618	

derived from refinery and related operations. In addition, all assets devoted to refinery operations and related activities are exempt from Puerto Rican property taxes until December 31, 1966.

The second grant of tax exemption in effect exempts from income tax two-thirds of all income from refinery operations and related activities for an additional three years — from January 1, 1967, until December 31, 1969 — and $10,000,000 of the refineries fixed assets from property tax for the same three years.

After expiration of tax exemption, Commonwealth Oil Refining will not be required to commence payment of income taxes immediately. Puerto Rican tax law specifically permits industrial companies, after expiration of tax exemption, to charge "flexible depreciation", which means that depreciable assets can be depreciated at any annual rate desired so as to reduce, or eliminate altogether taxable income for a period.

Another feature of Puerto Rico's tax exemption program is that dividends paid at any time from income derived from tax exempt operations during their first seven years are tax exempt for residents of Puerto Rico or of tax exempt jurisdictions.

Future

Commonwealth Oil Refinery's faith in the industrial growth of Puerto Rico is demonstrated by recent announcement of their intentions to expand their operations into the field of petrochemicals. The Company plans to commence construction early in 1962 of a plant (approximate cost $6.5 million) adjacent to the refinery for an initial production of 50,000,000 pounds per year of naphthalene and other aromatics.

CHEMICALS AND ALLIED PRODUCTS MANUFACTURED IN PUERTO RICO

E 1561

Acetylene

Adhesives

Adrenalin

Alcohol (aromatic, denatured ethyl)

Ammonia

Ammoniated Superphosphate

Ammonium Sulphate

Analgesic Cough Syrup

Anhydrous Ammonia

Anti-Mosquito Spirals

Antiseptics

Asphaltic compounds

Baby Powder

Bay Oil

Bay Rum

Bleaches

Carbon Dioxide

Caustic Soda*

Chlorine*

Colognes

Cosmetics

Cough Syrup

Detergents (powdered and liquid)

Diesel oil

Enamels

Ethylene Glycol

Ethical Pharmaceutical Products

Fertilizers (chemical and dry mix)

Fungicides

Fireworks

Gasoline

Germicides

Glycols

Hormones, Synthetic

Herbicides

Hair Dressing Perfumes

Hydrogen

Injectable Medicines

Insecticides

Lacquers

Laxatives

Liquid Gases

Medicines

Muriatic Acid

Nitrogen

Oxygen

Paints

Perfumes

Perfumed Alcohol in Bay Rum

Pharmaceuticals

Polyester Resin Compounds

Polyethylene*

Polyethylene films and bags

Polyurethane foam

Potassium Sulphate

Phthalic Anhydride*

Putty

Salt, Raw, Refined

Silicon

Soap

Sodium Hypochlorite

Steriod Hormones (synthetic)

Sulfate of Potash

Sulfur (elemental)

Sulfuric Acid

Superphosphate

Synthetic Plasma

Textile Dyes

Toilet Cream

Toilet Preparations

Tooth Paste

Varnishes

Vitamins*

Weed Killers

* To be Produced Shortly

MANUFACTURERS OF CHEMICALS AND ALLIED PRODUCTS IN PUERTO RICO

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Petroleum Refining:		
Caribbean Refining Co. Cataño, P.R.	Cosden Petroleum Corp. Big Spring, Texas and Gulf Oil Corp. Pittsburgh, Pa. (and) Pontiac Refining Co. Corpus Christi, Texas	Oil refining: liquid petroleum gas, gasoline, kerosene, diesel oil, fuel oil, elemental sulphur, etc. 1955
Commonwealth Oil Refining Co., Inc. Guayanilla, P.R.	Commonwealth Oil Refining Co. New York, N. Y.	Oil refining: liquid petroleum gas, gasoline, kerosene, diesel oil, fuel oil 1955
Industrial Inorganic and Organic Chemicals:		
Autoridad de Tierras Barranquitas, P.R.	Local	Calcium Carbonate
Autoridad de Tierras de Puerto Rico Programa de Producción de Carbonato Calizo Santurce, P.R.	Local	Calcium Carbonate
Caribe Nitrogen, Corp. Guánica, P.R.	W. R. Grace & Co. Memphis, Tenn.	Sulfuric acid, ammonium sulfate, anhydrous ammonia, calcium, superphosphate 1956
Destilería Serrallés, Inc. Ponce, P.R.	Local	Industrial alcohol 1936
Gas Product, Inc. Río Piedras, P.R.	Local	Oxygen and acetylene
Household Necessities, Inc. Cataño, P.R.		Bleaches, detergents 1960
Industrial Productora de Gas Ponce, P.R.	Local	Oxygen, acetylene and nitrogen 1945

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Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Industrial Inorganic and Organic Chemicals (cont'd.):		
International Metalloids Inc. Toa Alta, P.R.	W. R. Grace & Co. Baltimore, Md.	High purity silicon 1958
José del Río Morovis, P.R.	Local	Industrial alcohol
Liquid Air Inc. Cataño, P.R.		Liquid oxygen and nitrogen 1961
Northern Compressed Cases Inc. Cataño, P.R.	Local	Oxygen, acetylene 1959
Planta de Carbonato Calizo Aguas Buenas, P.R.	Local	Calcium Carbonate
Planta de Carbonato Calizo Ciales, P.R.	Local	Calcium Carbonate
Ponce Chemicals Industries Inc. Peñuelas, P.R.	Morton Chemical Co. Chicago, Illinois	Chlorine and caustic soda PE
P. R. Phosphate and Works (Division of Ochoa Fertilizer Corp.) Hato Rey, P.R.	Local	Muriatic acid, sulphate of potash, superphosphate 1936
Puerto Rico Distilling Co. Arecibo, P.R.	Local	Denaturated and ethylic alcohol
Puerto Rico Gases Corp. Mayaguez, P.R.	Local	Oxygen, acetylene 1950
Reichhold Chemical del Caribe, Inc.	Reichhold Chemicals, Inc. White Plains. N. Y.	Resins and plastic substances PE
Santamaría Gases, Inc. Bayamón, P.R.	Local	Oxygen, acetylene, nitrogen and carbon dioxide 1932

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Industrial Inorganic and Organic Chemicals (cont'd.):		
Stepan Chemical Ponce, P.R.	Stepan Chemical Northfield, Ill.	Phthalic anhydride PE
Union Carbide Caribe Inc. Peñuelas, P.R.	Union Carbide Int'l. New York, N.Y.	Glycols-monoethylene, diethylene, triethylene 1959
Primary Plastics Materials:		
Marson Corporation Hato Rey, P.R.	Marson Corp. Revere, Mass.	Polyester resin compounds 1959
Union Carbide Caribe Peñuelas, P.R.	Union Carbide Int'l. New York, N.Y.	Polyethylene and polyethylene compounds PE
Drugs and Medicines:		
Afleg Hemol Pharmaceutical Inc. Hato Rey, P.R.	Local	Multi-vitamins, tonics, cough syrups, capsules, anti-rheumatic and anti-allergenic products, etc. 1950
American Tropical Remedy Santurce, P.R.	Local	Medicines and toilet preparations 1956
Arroyo Pharmaceutical Corp. Arroyo, P.R.	Local	Multi-vitamins 1960
Arshell Laboratories Inc. Río Piedras, P.R.	Lawrence Rapport Chicago, Ill.	Intramuscular iron complex 1961
Baxter Laboratories of P.R. Hato Rey, P.R.	None	Intravenous solutions, expandable plastic administration sets, donor sets 1958
Calbiochem Caribe, Inc. Arecibo, P.R.	California Research Los Angeles, California	Biochemicals, hormones, vitamins, antibiotics PE

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Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Drugs and Medicines (cont'd.):		
Chemicals Inc. Luquillo, P.R.	Weller Electric Mfg. Co. Easton, Pa.	Synthetic plasma 1958
Compañía Industrial Farmaceutica, Inc. Santurce, P.R.	Local	Cathartics, analgesics and cough syrups, toilet preparations 1949
Dianovin Pharmaceuticals, Inc. Santurce, P.R.	Local	Capsules, tables, products for injections 1953
Dorasol Laboratories Río Piedras, P.R.	Local	Anti-fever, anti-spasmodic, analgesics and other preparations 1953
Emulsión Jiménez Cataño, P.R.	Local	Cod liver oil emulsion 1948
Eneglotaria Medicine Co. Santurce, P.R.	Local	Bay rum, cough syrups, anti-acid preparations, pomades and anti-biotic suspensions 1929
The Granchel Medicine Co. Hato Rey, P.R.	Local	Cough syrups, antacids, emulsions, rubbing alcohol, lotions 1944
Horner Laboratories Santurce, P.R.	Local	Injections, tablets, elixirs, granulations 1952
The Juvenilina Co. Ponce, P.R.	Local	Cough syrups, bay rum, liniments cosmetics, hair tints 1904
Laboratorios Flar-Arkadia (Flar Medicines Co.) Coamo, P.R.	Local	Skin lotions, rubbing alcohol, hair dye tablets 1930

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Drugs and Medicines (cont'd.):		
Laboratorios Seín Río Piedras, P.R.	Local	Cathartics, cough syrups, analgesics, tonics, antacids, elixirs 1956
Laboratorios Terrier, Inc. Hato Rey, P.R.	Local	Injections, cough syrups, tonics, tablets 1941
Manuel Marín Co. Mayaguez, P.R.	Local	Cough syrups, cathartics, antacids, liniments, tablets, eye drops, elixirs, tonics
Méndez Laboratorios de America Inc Hato Rey, P.R.	Local	Tablets, eye drops, elixirs, tonics 1945
Mentosan Laboratory Santurce, P.R.	Local	Liniments, pomades 1940
Nutritional Specialties Arecibo, P.R.	Universal Nutritions, Inc. New York, N.Y.	Vitamins, food supplements 1961
Nuclefort Medicine Co. Hato Rey, P.R.	Local	Tonics, syrups, liniments, ointments 1943
Parke Davis & Co. Carolina, P.R.	Parke Davis & Co. Int'l. Detroit, Mitch.	Vitamins, steri-vial, ampoules, antibiotics, capsules, anesthetics, other drugs 1960
Parke & Davis Co. #2 Carolina, P.R.	Parke Davis & Co. Detroit, Michigan	Injectable products PE
Robertson Laboratories Hato Rey, P.R.		Cough syrups, rubbing alcohol 1960
Pharmaceutical Products Co., Inc. Hato Rey, P.R.	Odgen Corp. New York, N.Y.	Drugs, chemicals, hormones 1950

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Rogatol Pharmaceutical Co., Inc. Hato Rey, P.R.	Local	Injectables, tonics anthelmintics 1944
Sterling Products Int'l. Inc. Hato Rey, P.R.	Sterling Drugs Inc.	Cough tablets and syrups, analgesics, anthelmintics, hair oils 1953
Town Pharmacal Inc Aibonito, P.R.	Local	Cough syrups, antharties, antacids, tonics 1952
Western Fher Labs., Inc. Ponce, P.R.	C. H. Boehringer Sohn	Pharmaceutical active ingredients 1961
Western Pharmacal Laboratories Mayaguez, P.R.	Local	Cough syrups, liniments , antacids 1961

Soap, Detergents and Cleaning Preparations, Perfumes, Cosmetics and Other Toilet Preparations:

Colgate Palmolive Co. San Juan, P. R.	Colgate Palmolive Co. New York, N. Y.	Dental cream PE
Commonwealth Soap Co. Trujillo Alto, P.R.	Local	Washing soap, coconut oil, refined animal fat 1961
Curtis Laboratories Inc. Hato Rey, P.R.	Local	Cosmetics and other toilet preparations 1956
Diversey of P.R., Inc. Hato Rey, P.R.	Diversey Corp. Illinois	Sodium hypochlorite, detergents and chemical compounds 1957
Edmundo Fernández, Inc. Bayamón, P.R.	Local	Toilet preparations 1961
Fábrica Barnés Santurce, P.R.	Local	Toilet preparations 1865

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Soap, Detergents and Cleaning Preparations, Perfumes, Cosmetics and Other Toilet Preparations (cont'd.):		
Hacienda Santa Elena Utuado, P.R.	Local	Bay oil 1950
Industrial Criollo Guaynabo, P.R.		Bay Rum
Insular Trading Co., Inc. San Juan, P.R.	Local	Toilet preparations 1946
Island Chemicals Inc. Cataño, P.R.	Crosfee Dyes & Chemical Brooklyn, New York	Textile dyes, Detergents and soaps 1960
Johnson & Johnson Interamerica Carolina, P.R.	Johnson & Johnson Interamerica New Brunswick, N. J.	Baby powder 1961
Kaufman & Co., Inc. Trujillo Alto, P.R.	Local	Anti mosquito spirals 1956
Laboratorios Gravi de P. R., Inc. Carolina, P.R.	Lab's Gravi Internacionales, S.A. Coral Gables, Fla.	Tooth paste, perfumes toiletries 1961
Multi-Chemical Products, Inc. Río Piedras, P.R.	Local	Liquid soaps, detergents 1954
P. R. Bay Oil Distilling Guayama, P.R.	Local	Bay oil
Puerto Rico Distilling Arecibo, P.R.	Local	Toilet preparations 1911
Paints, Varnishes, Lacquers, Enamels and Allied Products:		
American Paints Corp. Río Piedras, P.R.	Local	Paints 1957
Economy Products Co. Bayamón, P.R.	Local	Paints, lacquers, varnishes 1956
Fuller Co. (Caribbean), Inc. Bayamón, P.R.	W. P. Fuller & Co. San Francisco, California	Enamels, lacquers and paints 1961

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Paints, Varnishes, Lacquers, Enamels and Allied Products (cont'd.):		
Marson Corp. of P.R. Hato Rey, P.R.	Marson Corp. Revere, Mass.	Putty 1959
Superior Paints Mfg. Co. Guaynabo, P.R.	Local	Paints, lacquers 1952
Testor Adhesive & Paint Co. Bayamón, P.R.	Testor Chemical Co. Rockford, Illinois	Adhesives, paints adhesive enamel lacquers 1958
Agricultural and Miscellaneous Chemicals:		
Almacenes El Rey Guaynabo, P.R.	Local	Insecticides 1938
California Chemical Corp. Carolina, P.R.	California Spray Chemical Corp. Orlando, Fla.	Insecticides and fungicides 1953
Casco Sales Aguirre, P.R.	Local	Weed killers 1956
Felix Feliciano Morales Industrias Nacionales Santurce, P.R.	Local	Insecticides
Peko Manufacturing Arecibo, P.R.	Local	Insecticides
Southern Agricultural Chemicals, Inc. Ponce, P.R.	Local	Herbicides 1959
Vineland Chemical of P. R., Inc. Río Grande, P.R.	Vineland Chemical Vineland, N. J.	Herbicides (Industrial organic chemicals) 1960
Armour Chemical Agricultural Co. San Juan, P.R.	Local	Chemical fertilizers 1920
Cipriano Manrique, Inc. Caguas, P.R.	Local	Mixed fertilizers 1930
Marqués Comercial, Inc. Arecibo, P.R.	Local	Mixed fertilizers

Puerto Rican Name and Location	Mainland Affiliate	Product and Year Firm Established
Agricultural and Miscellaneous Chemicals (cont'd.):		
Ochoa Fertilizer Corp. Hato Rey, P.R.	Local	Fertilizers, potassium sulphate, super-phosphate 1950
San Miguel Fertilizer Corp. San Juan, P.R.	Local	Mixed fertilizers 1957
Super-A-Fertilizer Works, Inc. Mayaguez, P.R.	Local	Fertilizers 1959
Salinas de Rafael Pagán Guánica, P.R.	Local	Raw salt 1908
Ponce Salt Industries Corp. Peñuelas, P.R.	Local	Refined and raw salt 1959
Puerto Rico Salt Works, Inc. Cabo Rojo, P.R.	Local	Raw salt 1935
Salinas Botoncillo Lajas, P.R.	Local	Raw salt
Salinas Fortuna Lajas, P.R.	Local	Raw salt
Salinas Papayo, Inc. Lajas, P.R.	Local	Raw salt 1939
Salinas La Providencia Guánica, P.R.	Local	Raw salt
Fábrica de Fuegos Artificiales de Guillermo Rivera San Sebastián, P.R.	Local	Fireworks 1929
Andrés Lugo Viñas Santurce, P.R.	Local	Case sealing glue in paste
José Yulfo Soto Aguadilla, P.R.	Local	Fireworks

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COMMONWEALTH OF PUERTO RICO
ECONOMIC DEVELOPMENT ADMINISTRATION

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PROCESSING AND ECONOMIC DATA FOR A PROPOSED PUERTO RICO REFINERY

INTRODUCTION

The primary purpose of this study is to act as an aid in the investigation of the general economics and technology of a proposed 60,000 barrels per day (BPD) refinery processing a typical Venezuelan crude to produce normal petroleum fuels as well as the maximum feasible quantity of petrochemical raw materials and intermediates.

Included in this report are tables showing the operating cost and expenses, profitabilities and yield estimates of the various process units utilized in the original scheme and addendum thereto. Also, a general description of the processes with their flow diagrams are present.

The attached process and economic study is largely based on information developed and processed by Universal in regards to Puerto Rico. However, while the study has been prepared by us in accordance with established engineering practice and is useful in evaluating the proposed refinery and operations, it does not constitute any warranty, representation or guarantee with respect thereto. It is understood that Universal Oil Products Company's name shall not be used in connection with any prospectus or securities registration statement to be filed by your company with any governmental agency.

Product Price	$/Bbl.	¢/Gal.
Premium Gasoline	4.979	11.86
Regular Gasoline	4.628	11.02
No. 1 Fuel Oil	3.896	9.28
No. 2 Fuel Oil	3.430	8.17
No. 6 Fuel Oil	2.151	5.12
Pitch	1.800	4.29
L.P.G. (C_3)	2.964	7.06
Mixed C_3's	2.964	7.06
Mixed C_4's	2.964	7.06
Benzene	10.500	25.00
Toluene	7.560	18.00
C_8 Aromatics	6.300	15.00
Raffinate	4.041	9.62
Naphthalene, ¢/#	--	(5.0)

Operating Costs

In constructing the operating costs for a Puerto Rican refinery various costs such as labor, utilities, fringe benefits, operating personnel requirements as effected by local labor efficiency, and other associated costs were taken into general consideration based on knowledge from current similar operations present in Puerto Rico.

Estimated Process and Offsites Investment

The estimated capital investment for process and offsites facilities of the proposed schemes are based on curve estimates of current day costs of similar equipment erected at a U.S. Gulf Coast location. These cost estimates are subject to precise design definition; however, they are sufficiently accurate for planning purposes. There may be some question arise as to the differences that construction costs would be lower in Puerto Rico than the United States Gulf Coast. It is believed that all major items of equipment will be shipped in from the U.S. which will increase material costs somewhat over Gulf Coast prices. Labor prices are lower in Puerto Rico but considering the available pool of skilled labor in Puerto Rico to construct a 60,000 BSD refinery is quite small. A construction firm would need to import continentals to supply the skill job classifications. This labor cost as well as somewhat higher material costs should just about equalize capital investment in Puerto Rico to that at the U.S. Gulf Coast location.

Yield Estimates

The exactness of the yield estimates shown throughout are adequate for the purposes of this report, but will require confirmation for precise process designs. Depending on the final settlement of the type of crude to process and type of products to be produced will determine the process scheme as well as more precise yield.

In order to provide the highest reasonable degree of accuracy in the estimates made through this report, the respective product distribution and erected cost are based upon processes licensed by Universal Oil Products Company. Specific processes of the same general type will experience somewhat different product distribution and erected cost. Because of our greater familiarity with the specific capability and cost factors of these processes as compared with competing processes, the estimates shown in this report are based on processes as follows:

Specific UOP Process Used as Basis for Evaluation
Fluid Catalytic Cracking Process Unit (F.C.C.)
UOP Catalytic Condensation Process Unit
UOP 'HF' Alkylation Process Unit
UOP Platforming Process Unit
Unifining Process Unit
Udex Process Unit
Hydeal Process Unit
UOP Merox Process Unit

Other non-licensed processes and offsite facilities are the type that Universal has had many years of commercial experience in the design and economic evaluation.

Site Investigation Trip to San Juan

On February 20, 1962, a preliminary site survey was conducted in Puerto Rico.

The following are comments and general findings on the various locations viewed from the aerial and motor trip:

The north and east coasts of the island were ruled out due to lack of suitable unoccupied port sites. San Juan is already the site of one petroleum refinery and Roosevelt Roads is a U.S. Naval & Missile Base. Furthermore, the prevailing winds are northeasterly.

Five port sites were selected for consideration on the east, south and west coasts of the island, namely, Puerto Yabucca, Bahia de Jobos (Central Aguirre), Bahia de Guayanilla, Bahia de Guanica and Bahia de Anasco. Each of these prospective sites will be discussed in detail.

Puerto Yabucoa

Playa de Guayanes is a small town serving as a port for Yabucoa located five miles inland. Yabucoa has a population of 5,300 with general stores, two small hotels, a hospital and telephone and telegraph facilities. San Juan is located 50 miles northwest by highway. The sugar industry furnishes business for the town and port. Only vessels of 14-foot draft or less can enter the harbor and the passage is difficult. Vessels navigate in and out of the harbor during daylight hours only. Strong northeasterly afternoon breezes make two anchors on a vessel necessary. Deep water is 1700 yards off shore and unprotected from the weather. The bay is two miles wide with numerous reefs and sunken rocks. An extended area of level, firm ground runs back from the bay to Yabucoa.

Bahia de Jobos

The harbor of Bahia de Jobos consists of an anchorage 5 miles long and varying in width from 1/2 mile to 1 mile. However, only 50% of this area is of a depth of 23 feet or greater. The bottom is soft and ships' anchors would drag during a hurricane. The land surrounding this harbor is low-lying and swampy. However, farther inland there are extended areas of level, firm ground.

The town of Central Aguirre located on Bahia de Jobos has a population of 3,000 with telephone and telegraph services. The sugar industry has a pier here 1,300 feet long. Vessels drawing up to 23 feet can berth on either side of it.

Bahia de Guayanilla

Bahia de Guayanilla, located 7-1/2 miles west of Ponce, is the largest hurricane harbor, and one of the best in Puerto Rico. It can accommodate vessels of 40 feet draft or less. Commonwealth Oil Refining Company and Texas Company have wharves in this bay.

The town of Guayanilla with a population of 2,000 to 3,000 is located two miles inland and has no urban facilities. The limited amount of level ground between the bay and the town is rather low-lying for refinery construction. Punta Verraco, a point of land 1/2 mile wide and 1-1/2 miles long extending eastward outside the bay has no level land areas suitable for a refinery site without considerably land-leveling or benching and in time the area might prove to be rather cramped. Furthermore, a state forest is located just west of the bay and as a recreational resort might cause public relations problems for a petroleum refinery at some future date. The city of Ponce is located 12 miles to the east.

Bahia de Guanica

Bahia de Guanica is a good, natural harbor but too small and shallow for the berthing of oil tankers. Two small towns are located on the bay, Ensenada and Guanica. Each has a population of about 4,000 to 5,000. Telephone and telegraph services are available at both towns.

Bahia de Anasco

Bahia de Anasco is on the west coast of the island facing Mona Passage. Deep water runs in close to shore. In one area the water is 48 feet deep within 300 yards of the shore line. (This 48 feet depth area should be checked by sounding to confirm the hydrographic map.) On shore, extended areas of firm, level ground are available for choosing a refinery site, also electrical transmission lines run through this area. Judging from the lay of land sufficient fresh water should be available from water wells. However, in case additional water should be necessary, water reservoirs could be constructed without great difficulty in the hilly country just north of Bahia de Anasco.

The town of Anasco with a population of 3,500 is located 4 miles to the east of the bay and the city of Mayaguez with a population of 50,000 to 60,000 is located 12 miles to the south of the bay. Mayaguez has a shipping terminal that can accommodate vessels of 30 feet draft. This shipping terminal has a wharf 1200 feet long equipped with a shed 300 feet long by 60 feet wide plus various pieces of modern equipment for the mechanical handling of cargo.

Mayaguez has a number of stores and shops, two good hotels, telephone and telegraph service, an airport serviced by scheduled airline flights, plus a branch of the University of Puerto Rico. San Juan is 118 miles away by coastal highway. On Punta Higuero, 10 miles north of the bay, is a nuclear reactor in the construction stage.

After deliberating over the advantages and disadvantages of the five above-mentioned possible sites for a petroleum refinery, we believe that the Anasco Bay area should be chosen for the following reasons:

(1) A large area of firm, level land from which to choose a refinery site without pre-empting established settled areas.

(2) A bay which can be without difficulty fitted out with oil tanker berthing facilities.

(3) Likelihood of a good supply of fresh water.

(4) A petroleum refinery located here would be close to two centers of population - the town of Anasco and the city of Mayaguez. With these two centers of population nearby a ready-made labor market is at hand - already housed.

(5) The fact that there is a branch of the University of Puerto Rico in Mayaguez might be of interest to permanent refinery employees.

(6) Mayaguez has a suitable port for unloading construction material and refinery equipment with only a short haul to the refinery site.

(7) A petroleum refinery located on Bahia de Anasco would be in a favorable position to fuel ships sailing the Mona Passage.

(8) The area around Mayaguez and Bahia de Anasco has been by-passed by the rising tide of Puerto Rico economic development which is so evident at San Juan and Ponce.

(9) This area is serviced by a regularly scheduled airline as well as chartered flights.

(10) The area has a modern highway traversing it, backed up by a substantial secondary road system.

(11) Electrical power transmission lines run through this area with the power generating stations not too far away.

The only disadvantages that a petroleum refinery located near Bahia de Anasco would have is the fact that oil tankers serving the refinery would not have the protection of a suitable harbor like Bahia de Guayanilla.

A petroleum refinery located on Bahia de Guayanilla would have many of the same advantages listed for Bahia de Anasco, namely:

(1) It would be located close to a large center of population - the city of Ponce with a population of 100,000 to 110,000.

(2) Ponce has good port facilities.

(3) The area is served by a regularly scheduled airline as well as chartered flights.

(4) The area has a modern highway system.

(5) Electrical power generating stations are in the area.

(6) The Bahia de Guayanilla is an excellent harbor.

The disadvantages of locating a petroleum refinery in the Bahia de Guayanilla would be two:

(1) The smaller area of firm, level ground from which to choose a refinery site.

(2) The question of a good supply of fresh water must be investigated.

After reviewing the advantages and disadvantages of these two areas - Bahia de Anasco and Bahia de Guayanilla - it is apparent that the choice of a site hinges on whether oil tanker berthing facilities at Bahia de Anasco would cost a great deal more than similar facilities at Bahia de Guayanilla and, also, whether the Commonwealth of Puerto Rico wishes a further concentration of industry around Ponce or give the economy in the area around Bahia de Anasco and the city of Mayaguez a lift.

On Stream Time

345 stream days per year have been used giving a 95% on stream efficiency. For example, 60,000 barrels per stream day (BSD) of crude charge to the crude unit is 57,000 barrels per calendar day (BCD). The other 20 days left in the year are for process maintenance.

Utilities

Electricity - Assume purchase of power from Puerto Rico Water Resources Authority.

Refinery Fuel - Refinery fuel gases produced from the various processing units with the supplement requirements made up by using visbreaker pitch. Gaseous fuel deficiency would be made up by the pitch, which would be used preferably in the atmospheric and vacuum distillation and visbreaking unit.

Water Supply - A potable water supply for refinery sanitary facilities and steam boiler make-up is assumed to be ootained from fresh water wells. Process cooling water will be sea water.

Steam Generating Facilities - Sufficient refinery steam generating facilities have been provided even in the cases where a process having waste heat-steam generation facilities may be upset.

Inventories - Crude and Products

Since crude and product inventories tie up a large dollar value in a refinery of 60,000 BSD capacity, a strict control and review should set policy on this matter. It is assumed that crude inventory is twenty days for this size refinery. A leasing of super tankers to handle crude delivery should be investigated. A round trip for crude delivery by super tanker is considered about 5-8 days between Venezuela and Puerto Rico.

The majority of the products produced are considered for exporting to the east coast of the United States. A reasonable inventory was taken into account for the products considering time necessary for a round trip and quantity of material available for shipment by T-2 tankers.

A thorough investigation of the pitch and LPG local markets will aid in determining the economics of supplementary refinery fuel gas with either pitch or LPG. Large LPG inventories can be costly from the storage standpoint.

Acquirement of Total Capital Investment

The total capital investment was assumed to be raised by the following means as stipulated by Omega Management Incorporated.

20% of capital investment will be equity capital

80% of capital investment will be convertible sinking funds debentures, 6% interest rate, 20-year term.

In determining the economics of the two cases, it was assumed that the yearly sinking fund payment is 1/20 of the total debentures. Yearly payment is made at the end of the year and from income after taxes. The 6% interest rate on the sinking fund debentures is one the year beginning unpaid balance of debentures.

Equity capital is in the form of common stock.

Income and Property Tax

During the first ten years of the proposed cases no corporate income or property tax is due. The rates used after that are based on the current rates as developed by the Department of the Treasury, Commonwealth of Puerto Rico and listed in "What You Should Know About Taxes in Puerto Rico," 1961 edition.

Depreciation Rates and Items

Depreciation rates and items used in the economics of the two cases are considered normal for a typical refinery. However, there are always extremes from the average for various reasons and is determined by company policy, within government regulations.

Process and offsites facilities and starting capital are considered the depreciable items. Depreciation rate is as follows:

1. Process capital - straight line on 15 years life - 10% salvage value
2. Offsites capital - straight line on 20 years life - 10% salvage value
3. Startup capital - straight line on 10 years life.

PROCESSING AND ECONOMIC DATA FOR A PROPOSED PUERTO RICO REFINERY

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BASIC CONSIDERATIONS

In performing the study certain assumptions were made and are listed in this section under various categories.

Crude Oil Supply and Price

In reviewing the crude oils that are available from Venezuela, several crudes were found to be typical and in sufficient production quantity that could supply the needs of the proposed refinery. For this study, a Venezuelan crude known as Tia Juana Medium crude was used. This crude is believed to be available for long term contracts. A laid-in price at the refinery for this crude was taken at $2.35/bbl.

Product Market and Prices

The quantity of petroleum products produced from a 60,000 BCD refinery located in Puerto Rico were assumed to be, to a great extent, exported out of the country to the east coast markets of the United States. Current output of the two refineries presently in Puerto Rico far outdistances current and future demands of petroleum fuel for local market consumption. A relatively high percentage of the current refinery outputs are exported to the east coast markets. The assumption was also made with petrochemical raw materials and intermediates although joint ventures or future petrochemical expansion would limit the export of petrochemicals so derived.

Therefore, all petroleum fuel products and petrochemical material were assumed to have sufficient export and local markets to absorb all production quantities. It is suggested than an organization contemplating entering in the refining or petrochemical industry should make a close examination to determine their market position as to the type of products and quantities they wish to handle under long term manufacturing contracts.

Product prices used in the study are believed to be those generally applicable to those received at the refinery gates in the Puerto Rico area. They are a combination of local market prices and export market prices.

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

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PROCESS DESCRIPTION AND YIELDS

INTRODUCTION

Block flow diagram No. 76845-C-O shows the general processing scheme that is utilized in this case. The main considerations were to design a refinery with a maximum of flexibility to produce normal petroleum fuels and a maximum of petrochemicals and petrochemical feedstocks. The flexibility of design is required to provide additional petrochemicals and petrochemical feedstocks in the future.

The process flow is described below:

CRUDE DESALTING

While the crude used for this study does not show an appreciable amount of salt, electrical desalting equipment is provided to enable crudes to be processed, which are less satisfactory in this regard.

ATMOSPHERIC DISTILLATION

In this scheme one 60,000 BSD unit is considered rather than the possibility of two smaller units of 30,000 BSD capacity each.

Preflashing or prefractionation is chosen to give the most economical use of heat. A light straight run stabilizer is provided. The Tia Juana Medium light straight run in particular needs to be stabilized and while the stabilizer could be omitted with the light straight run stabilized in the FCC Gas Recovery unit, this would reduce operating flexibility. Only one grade of gasoline then could be produced.

A light naphtha, 165-270°F., is taken overhead from the atmospheric crude column and is processed in a Unifiner for sulfur removal and is further processed as described later. A heavy naphtha, 270-450°F., is taken as a side stream from the crude column and is processed in a Unifiner for sulfur removal and to further processing as described later. A middle distillate (450-650°) is taken as a side stream from the crude tower, processed in a Unifiner for sulfur reduction and sent to storage as a finished product. The reduced crude from the bottom of the crude tower is sent to vacuum unit.

VACUUM DISTILLATION

The function of this unit is to prepare vacuum gas oil as charge to the FCC unit. It should be designed carefully to keep entrainment of asphalt from the gas oil to a minimum and thus at the same time keep the metal contaminants, harmful to the FCC operation, at a minimum in the FCC feed. The vacuum pitch obtained from the bottom of the vacuum unit is sent to the visbreaking unit.

VISBREAKING UNIT

Visbreaking is particularly advantageous in a dual process function. It prepares distillate stocks and at the same time reduces the viscosity of residual bottoms so that less cutback material is required to meet No. 6 fuel oil specification. Light materials from this operation are sent to FCC Gas Recovery system for recovery of the C_3's and C_4's. The visbreaker gasoline is split into two fractions, a C_5-270°F. and a 270-400°F. material. Each fraction is joined with the respective virgin naphtha fraction, processed in a Unifiner for sulfur reduction and olefin saturation, and then to further processing as described later. The vacuum pitch is sold with cycle stock (FCC cycle oils) as No. 6 fuel oil or burned as a fuel within the refinery or by other industrial consumers close to the refinery.

FLUID CATALYTIC CRACKING AND GAS RECOVERY UNITS

This system of Catalytic Cracking has been chosen as it has been most widely accepted in the industry and is the most representative. The function of this unit is to convert heavy distillate oils into high octane gasoline and to reduce the overall refinery fuel oil production. Current designs are noted for simplicity, ease of operation and low operating and investment costs. The process also gives good yields of mixed C_3 and C_4 saturate and olefin compounds which can be used for alkylation, catalytic condensation or for petrochemical intermediates.

Charge stock for the FCC has been prepared by the vacuum unit. A conversion level of 70% has been used in this scheme for maximizing light olefin production. However, as mentioned in the introduction, if the pitch sales are not large, conversion level could be reduced for sufficient cycle oils to be produced for blending into No. 6 fuel oil.

FLUID CATALYTIC CRACKING
AND GAS RECOVERY UNITS (Cont'd)

The gas recovery section (gas concentration) may receive, in addition to the light products from the FCC unit, light products from other refinery sources as straight run stabilizer overhead, Platforming debutanizer overhead and the visbreaking light material. The gas recovery section produces fuel gas, mixed C_3's and C_4's and a debutanized gasoline which is routed to the gasoline pool as a blending component.

LIGHT AND HEAVY NAPHTHA UNIFINING UNITS

An uncomplicated, easily operated process for eliminating sulfur, nitrogen and metallic impurities from petroleum distillates, Unifining provides a simple and economical answer to an operating problem that is frequently difficult and costly to solve by other methods. Also Unifining will simultaneously saturate any olefin present in the feedstocks. It clearly removes impurities and prepares feedstocks of ideal properties for further processing.

Unifining works particularly well in combination with Platforming. It is ideal for pretreating Platformer feedstocks and the excess hydrogen from the Platformer is an excellent, low cost hydrogen source for the unit.

The feed to each of the naphtha Unifiners is comprised of the respective boiling range virgin naphthas from the crude unit and the visbreaker gasolines. Sulfur reduction and olefin saturation occurs during this operation. Hydrogen required for these steps is received from the Platforming unit. H_2S and light materials produced during Unifining are stripped in the Unifiner stripper. The stripper bottoms then become charge to the Platforming unit.

B-T-X PLATFORMING AND
HEAVY NAPHTHA PLATFORMING UNITS

This is one of the most widely used processes in the refining industry. In operation on a broad scale it has proved to be practical and an economical process for upgrading low octane gasolines.

Platformer feedstock is received from the Unifiner stripper. Processing conditions are selected so that a 90 F-1 clear C_5+ Platformate is obtained from the Platformer debutanizer and is routed to the gasoline pool as a high octane

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B-T-X PLATFORMING AND
HEAVY NAPHTHA PLATFORMING UNITS (Cont'd)

blending component. The debutanizer overhead material is sent to the FCC recovery unit for recovery of propane, iso and normal butanes present in the streams. The net separator gas becomes a source of low cost hydrogen for the Unifining operation.

Under proper operating conditions, Platforming fits well into the growing demand for petrochemicals as it is highly efficient for producing a material that contains aromatics such as benzene, toluene and xylenes and these can be readily extracted from the Platformate. As in this scheme, a Unifined naphtha in the boiling range of 165-270°F. is the feedstock for B-T-X Platforming operations. A depentanized Platformate is obtained and this becomes feedstock to a Udex unit as described later. A C_5's and C_4's fraction is recovered and sent to the gasoline pool as a blending component. The depropanizer overhead material is sent to the FCC gas recovery unit for recovery of propane. The net separator gas becomes a source of low cost hydrogen for the Unifining operation.

Within a recent period, under proper operating conditions, it has been found that the Platforming process may produce a material from which naphthalene could be derived. As in this scheme, a Unifined naphtha in the boiling range of 270-450°F. is the feedstock for heavy naphtha Platforming operations. A total depropanized Platformate is obtained which is rerun into a C_4-390°F. and a 390-E.P.°F. fraction. The C_4-390°F. fraction is routed to the gasoline pool as a blending component. The 390°-E.P. fraction becomes a feedstock for further processing as described later for naphthalene production. The depropanizer overhead material is sent to the FCC gas recovery unit for recovery of propane. The net separator gas becomes a source of low cost hydrogen for the naphthalene operation.

DISTILLATE UNIFINING

This proposed method of distillate treating, where hydrogen is available, is based on Universal's considerable experience in the Unifining of distillate oils. Sulfur reduction to meet specifications is the prime function of this operation and the required reduction is readily obtained.

The middle virgin distillate (450-650°F.) as obtained from the crude column combines with a necessary portion of the B-T-X Platformer net separator gas and after heating passes into the Unifiner reactor system. Sulfur reduction in the distillate fraction is the prime purpose of this operation. The product after the Unifiner reactor is stripped and rerun to meet flash point specification to give a product as No. 2 fuel oil.

UDEX EXTRACTION AND B-T-X RECOVERY UNIT

The Udex process is designed to prepare high purity aromatics from catalytic reformate. The Udex process has been proved commercially to be an outstanding method for the preparation of aromatics of purities not previously attained. The aromatic products of the Udex process will not only meet the established ASTM nitration grade specifications but will exceed them. Nitration grade benzene has a minimum solidification point of 4.85°C. The benzene produced commercially from catalytic reformate processed in Udex units has consistently been well above the 5.40°C solidification point. The toluene fraction will have comparable freedom from paraffin impurities. High aromatic product purities are attained which maintains high recovery efficiencies. The benzene recovery efficiency attained in commercial Udex operation has been well above 99%.

The feedstock for the Udex unit in this proposed scheme is the depentanized Platformate obtained from the B-T-X Platforming operation. Through the extraction step, the extract product so obtained has a high purity aromatic content.

However, the extract contains traces of unsaturates, which would limit the purity of the final products and may also contain traces of residual non-hydrocarbon compounds which would spoil the acid-wash color test of the final products. To destroy these trace impurities the extract is processed through Attapulgas or similar clay before final distillation.

UDEX EXTRACTION AND
B-T-X RECOVERY UNIT (Cont'd)

Redistillation of the product is accomplished in three columns in succession making pure benzene and toluene respectively as overhead products, a C_8 aromatic fraction as overhead product and a C_9 plus aromatics product off the bottom of the xylene column.

The isomer distribution in the C_8 aromatic fraction derived from petroleum stocks is approximately:

	Vol.%
ethylbenzene	20
p-xylene	18
m-xylene	42
o-xylene	20

The raffinate obtained from the extraction step is highly paraffinic and needs very little treatment before it is sent to storage. It can be used as a low octane blending component, a jet fuel blending component, or a charge stock for an ethylene cracking process.

HYDEAL

The Hydeal Process is a new process recently announced by Universal. This process is designed for the conversion of alkylbenzenes to benzene or alkylnaphthalenes to naphthalene.

The Hydeal unit proposed for this scheme is designed to convert alkylnaphthalenes to naphthalene. Feedstock is derived from the Heavy Naphtha Platforming operation. The 390-E.P.°F. Platformate fraction usually contains sufficient quantities of alkylnaphthalenes for economical conversion of these compounds into naphthalene. Also present in these feedstocks are some alkylbenzenes that are converted to benzene. The hydrogen source for this reaction is the net separator gas from the Heavy Naphtha Platforming operation.

MEROX

The UOP Merox Process is a fairly new process announced by Universal and is additional evidence of UOP's policy of providing the refining industry with every means for a well-rounded, profitable manufacturing operation. This process provides a low cost operation for treating gasoline and lower boiling fractions for removal of mercaptans, or sweetening heavier stocks by converting mercaptans to disulfides.

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PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

ADDENDUM

ISOMAX CASE

An alternative scheme with respect to the base case considered in our study of April 13, 1962 is presented herewith.

The alternate case included the following changes with respect to the base case:

1. The Fluid Catalytic Cracking Process unit has been replaced by an Isomax Process unit.

2. A hydrogen manufacturing plant has been added to satisfy hydrogen requirements for the Isomax Process unit.

3. The aromatics producing facilities have been increased in size. Additional charge will be gasoline from the Isomax Process unit.

The same general statements and assumptions as presented in the base case apply to this alternate case.

Block flow diagram No. 76845-C shows the general processing scheme of the Isomax Case. The main considerations were to produce normal petroleum fuels that will meet general product specifications as well as producing petrochemicals.

Attached tables I through XXII show economic and technical information on this alternate case.

The scheme presented indicates a fairly good return of common equity. It is estimated that a 60,000 B/D refinery following this scheme can be built in Puerto Rico at a cost of about $68 million, including working capital and start-up expenses. This cost exceeds the base case cost by $11 million. However, the payouts in both cases are similar and the net earnings on equity in the Isomax Case are over $9 million above the base case in a 20-year period.

The alternate case offers the following additional advantages:

1) The Isomax Process is characterized by an inherent ability to process a widely diversified range of charging stocks. Included in the list are not only the virgin stocks varying in boiling range from kerosenes to heavy vacuum gas oils, but thermal and catalytic cycle stocks as well.

2) In addition to versatility as regards charging stock Isomax is a very flexible process. Never before have refiners had such control over maximizing gasoline production or conversely middle distillate production. This is particularly important in order to meet changing market demands.

3) Due to the flexibility of Isomax, product inventories can be reduced.

4) The naphtha produced in an Isomax unit is an excellent feedstock for Platforming to produce high grade gasoline and/or aromatics.

5) High quality middle distillates are produced with Isomax.

PROCESSING AND ECONOMIC DATA

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FOR A PROPOSED PUERTO RICO REFINERY

TABLE II

ESTIMATED DIRECT OPERATING COST

	$/SD
1. Refinery Labor	
Including Maintenance, Safety, Warehouse and Utilities	6,868
2. Tetraethyl Lead	
Cost @ 0.25¢/cc T.E.L.	1,645
3. Maintenance - Offsites and Process	5,985
4. Laboratory and Miscl. Supplies	200
5. Catalyst	
(a) Isomax catalyst @ 30 bbls/lb per stage @ $1.60/Lb	1,517
(b) Platforming catalyst	
1. B-T-X Platformer - 50 bbl/lb	623
2. Hvy.Naph.Platformer - 55 bbl/lb @ $3.45/lb net replacement	839
(c) Unifining catalyst	
1. Naphtha Unifiner @ 200 bbl/lb @ $1.60/lb	116
2. Distillate Unifiner @ 200 bbl/lb @ $1.05/lb	62
(d) Hydeal catalyst @ 5 bbl/lb @ $1.00/lb	248
Total Catalyst	3,405
6. Chemicals and Inhibitor	
(a) Gasoline additives	
1. Sweetening agent 3 lbs/1000 bbls @ $1.00/lb	39
2. Corrosion inhibitor, 6 lbs/1000 bbls @ 39¢/lb	30
3. Metal inhibitor 1 lb/1000 bbls @ $1.00/lb	13

(contd.)

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TABLE II (contd.)

ESTIMATED DIRECT OPERATING COST

	$/SD
6. Chemicals and Inhibitor (contd.)	
(b) Corrosion inhibitor, ammonia, lime, amine, etc. @ 30¢/lb	42
(c) Water treating, $1.50 per day/1000 GPM Circ.	121
(d) Glycol @ 0.1 lb glycol/bbl of charge @ 17¢/lb	125
(e) Clay @ 0.5 lb clay/bbl of aromatics @ $30/ton	23
Total Chemicals	393
7. Royalties (Running Basis)	
(a) Isomax 5.5¢/bbl charge	782
(b) Platforming @ 5.5¢/bbl charge	1,234
(c) Unifining	
Naphtha Unifining - waiver	-
Distillate Unifining @ 1.5¢/bbl charge	178
(d) Hydeal @ 5% of naphthalen sale value and 0.5¢/gal benzene	797
(e) UDEX @ $750,000 amortized over 10 years	73
Total Royalties	3,064
8. Insurance	
Estimated @ 2.0% of process, offsites and inventories	3,678
9. Utilities	
Electricity @ 1.0¢/KWH	3,969
Fuel*	6,232
Cooling water @ 0.9¢/1000 gals once-through	770
Steam @ 55.0¢/1000 lb	2,033
Total Utilities	13,004
Total Direct Operating Cost	38,242

*Pitch used to supplement refinery gas.

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

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TABLE III

ESTIMATED UTILITIES

Electricity	KW
Crude, Vacuum and Stabilizer Units	575
Light Naphtha Unifining Unit	290
Heavy Naphtha Unifining Unit	405
Distillate Unifining Unit	800
B-T-X Platforming Unit	1,632
Heavy Naphtha Platforming Unit	1,985
UDEX Unit	390
Naphthalene Hydeal Unit	1,310
Isomax and Gas Concentration Units	5,060
Visbreaking Unit	550
Hydrogen Plant	450
Subtotal	14,047
Offsites and Miscellaneous	2,490
Total	16,537

Fuel	10^6 BTU/Hr
Crude, Vacuum and Stabilizer Units	-327
Light Naphtha Unifining Unit	- 31
Heavy Naphtha Unifining Unit	- 46
Distillate Unifining Unit	- 38
B-T-X Platforming Unit	-142
Heavy Naphtha Platforming Unit	-185
UDEX Unit	- 3
Naphthalene Hydeal Unit	- 94
Isomax and Gas Concentration Units	-170
Visbreaking Unit	-104
Hydrogen Plant	-450
Subtotal	-1,590
Boiler House	-166
Total	-1,756

BTU/Day required	42,140 x 10^6 BTU
BTU/Day from fuel gas	18,720 x 10^6 BTU
BTU/Day needed to be purchased	23,420 x 10^6 BTU

Therefore 3,720 B/D pitch used to supplement refinery fuel gas.

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TABLE III (contd.)

ESTIMATED UTILITIES

Page 2

Cooling Water	GPM
Crude, Vacuum and Stabilizer	10,850
Light Naphtha Unifining Unit	980
Heavy Naphtha Unifining Unit	1,450
Distillate Unifining Unit	1,790
B-T-X Platforming Unit	4,050
Heavy Naphtha Platforming Unit	6,090
UDEX Unit	6,600
Naphthalene Hydeal Unit	6,000
Isomax and Gas Concentration Units	4,700
Visbreaking Unit	4,300
Hydrogen Plant	12,500
Miscellaneous	100
Total	59,410

Steam	1,000 Lbs/Hr
Crude, Vacuum and Stabilizer	-39.0
Light Naphtha Unifining Unit	-
Heavy Naphtha Unifining Unit	-
Distillate Unifining Unit	-
B-T-X Platforming Unit	-
Heavy Naphtha Platforming Unit	-
UDEX Unit	-99.0
Naphthalene Hydeal Unit	- 1.6
Isomax and Gas Concentration Units	-
Visbreaking Unit	-
Hydrogen Plant	-
Miscellaneous	-14.4
Total	-154.0
Visbreaker Steam Generator	+19.0
Boiler House	+135.0
Total	+154.0

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

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TABLE IV

ESTIMATED PERSONNEL REQUIREMENTS

Management	Per Day*
Manager	1
Assistant Manager)	1
Process Superintendent)	
Chief Engineer)	1
Mech. Superintendent)	
Personnel Manager	1
Chief Chemist	1
Comptroller	1
With above:	
Secretaries	6
Total Management	12

Office	
General Accounting Manager)	1
Refinery Acccunting Manager)	
Oil Accounting Manager	1
Material Accounting Manager	1
Accounting Clerks	2
Yield Accountant	1
Billing Clerk	1
Tanker Agent	1
Payroll Clerk	3
Shipping Clerk)	3
Purchasing Agent)	
Office Service:	
Receptionist/Telephone Operator	1
Stenographers and Typists	8
Total Office	23

Laboratory	
Chemists	6
Knock Tester	1
Podbielniak Operator	1
Technicians	11
Washers	3
Samples	4
Total	26

*5 day work week - 8 hours per day.

(cont'd.)

TABLE IV (contd.)

ESTIMATED PERSONNEL REQUIREMENTS

Page 2

	Per May's
Safety	
Chief Safety Engineer	1
Assistant Chief Safety Engineer	1
Fireman and Safety Personnel	6
Total	8
Technical and Economics - Case I - Case II	
Technical Superintendent)	
Economics Superintendent)	1
Engineers	6
Secretary	1
Total	8
Warehouse	
Chief Storekeeper	1
Assistant	2
Clerks	2
Helpers	6
Total	11
First Aid	
Doctor	1
Medical Assistant	1
Nurses	3
Total	5
General Workers and Security	
Chief Watchman	1
Shift Watchman	15
Porters	4
Yardmen	4
Total	24

TABLE IV (contd.)

ESTIMATED PERSONNEL REQUIREMENTS

Page 3

Maintenance	Per Day*
Chief Mechanical Engineer	1
Chief Civil Engineer	1
Draftsmen	1
Mechanical Foreman	1
Pipefitters	3
Pipefitters Helpers	3
Welders	2
Welders Helpers	2
Machinists	4
Machinists Helpers	1
Pump Mechanics	3
Pump Mechanics Helpers	3
Boiler Makers	4
Boiler Makers Helpers	4
Chief Electrician	1
Electricians	3
Electrician Helpers	3
Instrument Men	6
Carpenters	2
Carpenters Helpers	2
Painters	2
Painters Helpers	2
Insulator	1
Bricklayers	1
Bricklayers Helpers	1
Mason	2
Mason Helpers	2
Truck Drivers	3
Garage Mechanics, etc.	1
Labor Foremen	1
Laborers	6
Total	136

Oil Movement	
Superintendent	1
Assistant Superintendent	1
Cargo Inspector	1
Pumpers	9
Pumpers Helpers	9
Gaugers	9
Dock Clerks	3
Pumpers	3
Pipe Fitters	4
Pipe Fitters Helpers	12
Truck Loaders	4
Truck Loaders Helpers	4
Oil Separator Operators	4
Total	57

(contd.)

TABLE IV (contd.)

ESTIMATED PERSONNEL REQUIREMENTS

Page 4

Operations	Per Shift
Shift Foreman	1
Crude, Vacuum and Stabilizer	
Senior Operator	1
Board Man	1
Helper	2
Visbreaking Unit	
Senior Operator	1
Board Man	1
Helper	1
Naphtha Unifiner - BTX Platformer-UDEX	
Senior Operator	1
Board Man	2
Helper	3
Naphtha Unifiner - Platformer - Hydeal	
Senior Operator	1
Board Man	2
Helper	3
Distillate Unifiner	
Senior Operator	1
Helper	1
Isomax, Hydrogen Plant and Gas Concentration	
Senior Operator	1
Board Man	1
Helper	2
Boiler House	
Senior Operator	1
Water Treating and Pumping	2
Treaters and Splitter	
Board Man	1
Helper	1
Total	31

PROCESSING AND ECONOMIC DATA E 1598

FOR A PROPOSED PUERTO RICO REFINERY

TABLE V

ESTIMATED PERSONNEL REQUIREMENTS AND COSTS

	No.	$/SD
Management	12	642
Office	23	262
Laboratory	26	346
Safety	8	100
Technical and Economics	8	176
Warehouse	11	182
First Aid	5	63
General Workers and Security	24	300
Maintenance	138	1,800
Oil Movement	62	583
Operations	131	2,414
Total	448	6,868

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PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE VI

ESTIMATED PROCESS INVESTMENT

Process Units	Material and Labor Costs
1. Crude Unit Including desalter, full corrosion protection and stabilizer	$ 2,000,000
2. Vacuum Unit	1,200,000
3. Light Naphtha Unifining Unit	550,000
4. Heavy Naphtha Unifining Unit	700,000
5. Distillate Unifining Unit	1,200,000
6. B-T-X Platforming Unit	1,800,000
7. Heavy Naphtha Platforming Unit	2,250,000
8. UDEX Unit	1,850,000
9. Naphthalene Hydeal Unit	3,100,000
10. Isomax and Gas Concentration Unit	6,600,000
11. Visbreaking Unit	2,100,000
12. Hydrogen Plant	2,750,000
13. C_3/C_4 Merox Unit	60,000
Process Units - Total M and L	$26,160,000
Design, engineering, contractor's expense and overhead	5,340,000
Total	$31,500,000
Allowance for ocean freight, local freight, unloading and hauling to site	$ ~~2,300,000~~

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

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TABLE VII

ESTIMATED OFFSITES FACILITIES INVESTMENT

	Material and Labor
Utilities	
Steam generating system	
Water treating facilities	
Fresh water supply	
Refinery fuel system	
Cooling water system	
Electric power system	
Compressed air system	
	$ 3,100,000
Service Facilities	
T.E.L. blending	
Fire fighting equipment	
Refinery flare and blowdown system	
Oil separation and retention pond	
Sewer system	
Telephone system	
Fencing and gates	
Roads and parking areas	
Truck load racks	
	1,400,000
Buildings and Contents	800,000
Tankage and Accessories	
Tankage	
Tankage accessories	
Transfer pumps	
Yard piping	
	10,000,000
	$15,300,000
Design, engineering, contractor's expense and overhead	3,000,000
	$18,300,000
Allowance for ocean freight, local freight unloading and hauling	2,300,000

Not included in above estimates are the following:

Land
Docks and wharfs
Site preparation
Piling if required

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE VIII

ESTIMATED INITIAL INVENTORY REQUIREMENTS

	Barrels	Dollars
1. Charge Stocks		
Crude, 20 day inventory	1,200,000	2,820,000
2. Products		
Gasoline		
Premium, 25 days inventory	97,850	487,200
Regular, 25 days inventory	228,330	1,056,700
Benzene, 30 days inventory	28,000	352,800
Toluene, 30 days inventory	31,700	239,700
C8 Aromatics, 30 days inventory	33,100	208,500
Raffinate, 25 days inventory	119,500	482,900
Naphthalene, 30 days inventory	20,500	411,500
Mixed C3's, 15 days inventory	25,900	76,800
Mixed C4's, 15 days inventory	25,100	74,400
No.2 Fuel Oil, 25 days inventory	125,000	428,700
No.6 Fuel Oil, 25 days inventory	329,300	708,300
Total	1,064,280	4,527,500
3. Catalyst Initial Loading and a Spare Loading	Pounds	
Isomax	540,600	865,000
Naphtha Unifiners	64,600	103,400
Distillate Unifiner	44,500	46,700
B-T-X Platformer	52,600	286,700
Hvy. Naphtha Platformer	108,500	857,200
Hydea	125,600	125,600
Total	2,123,100	2,284,600
4. Spare Parts	-	1,250,000
Total		8,062,100

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

E 1602

TABLE IX

ESTIMATED STARTUP AND WORKING CAPITAL

Section 1 - Startup Capital

A.	Labor - 60 days supervision	$ 267,200
	30 days operating and training	72,400
B.	Utilities - 30 days startup and training	407,250
	Total Startup Capital to Depreciable Capitalization	$ 746,850

Section 2 - Working Capital

A.	Charge Stock - 20 days inventory	$ 2,820,000
B.	Products - necessary inventory	4,527,500
C.	Direct Operating Costs - 30 days	757,140
	Total Working Capital to Non-Depreciable Capitalization	$ 8,104,640

PROCESSING AND ECONOMIC DATA

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FOR A PROPOSED PUERTO RICO REFINERY

TABLE X

ESTIMATED TOTAL INVESTMENT

Initial Catalyst and Chemical Loading and Spare Parts	$ 3,534,600
Process Investment	35,500,000
Offsites Investment	20,600,000
Startup and Working Capital	
(a) Depreciable	746,850
(b) Non-depreciable	8,104,140
Total	$ 68,485,590

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PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XI

ESTIMATED GROSS MANUFACTURING MARGIN

Products	B/D	$/Bbl	¢/Gal	$/D
Gasoline, Premium	3,914	4.979	11.86	19,488
Regular	9,133	4.628	11.02	42,268
Total	13,057			61,756
Benzene	932	12.60	30.00	11,743
Toluene	1,058	7.56	18.00	7,998
C8 Aromatics	1,104	6.30	15.00	6,955
Raffinate	4,779	4.041	9.62	19,276
Naphthalene (¢/Lb)	687	-	(5.0)	13,716
Mixed C3's	1,725	2.964	7.06	5,113
Mixed C4's	1,674	2.964	7.06	4,962
No. 2 Fuel Oil	17,458	3.430	8.17	59,881
No. 6 Fuel Oil	5,000	2.151	5.12	10,755
Pitch	13,172	1.800	4.29	23,710
Value of Production	60,646			225,865
Charge				
Crude	60,000	2.350	5.60	141,000
Cost of Raw Material				141,000
Gross Manufacturing Margin				84,865

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XII

ESTIMATED REFINERY CONSOLIDATED YIELDS

Charge	B/D	Vol.%	Lbs/Hr	Wt. %
Tia Juana Medium Crude	60,000	100.0	780,046	100.00
Refinery Yield				
1. Gasoline				
Lt.St.Run	3,404	5.7	30,243	3.88
C_4-390° F Platformate	9,653	16.1	110,382	14.15
	13,057	21.8	140,625	18.03
2. Benzene	932	1.6	11,986	1.54
3. Toluene	1,058	1.8	13,250	1.70
4. C8 Aromatics	1,104	1.8	13,783	1.77
5. Raffinate	4,779	8.0	49,353	6.33
6. Naphthalene	687	1.1	11,430	1.47
7. Mixed C_3's	1,725	2.9	12,938	1.66
8. Mixed C_4's	1,674	2.8	14,386	1.84
9. No. 2 Fuel Oil	17,458	29.1	155,960	20.00
10. No. 6 Fuel Oil	5,000	8.3	79,145	10.15
11. Pitch*	13,172	22.0	212,631	27.23
12. Fuel Gas (F.O.E.)	2,975	5.0	64,558	8.28
	63,621	101.7	780,046	100.00

*Includes 3,720 B/D pitch used to supplement refinery fuel gas.

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PROCESSING AND ECONOMIC DATA
FOR A PROPOSED PUERTO RICO REFINERY

TABLE XIII

ESTIMATED CRUDE UNIT YIELDS

Charge	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lb/Gal
Tia Juana Medium Crude	27.1	60,000	100.0	780,000	100.0	7.429
Yields						
IBP - 165° F	-	2,040	3.4	17,706	2.27	-
165-270° F	62.0	5,100	8.5	54,288	6.96	6.087
270-450° F	45.4	7,680	12.8	89,544	11.48	6.660
450-650° F	38.6	11,880	19.8	143,988	18.46	6.926
650-1000° F	19.9	14,220	23.7	193,674	24.83	7.783
Vac. Bottoms	8.6	19,080	31.8	280,800	36.00	8.412
		60,000	100.0	780,000	100.00	

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PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XIV

ESTIMATED VISBREAKING YIELD

Charge	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lbs/Gal
Vacuum Bottoms	8.6	19,080	100.0	280,800	100.0	8.412
Yields						
H_2S				618	0.22	
H_2				28	0.01	
C_1				899	0.32	
C_2=				365	0.13	
C_2				1,207	0.43	
C_3=		153	0.8	1,151	0.41	
C_3		210	1.1	1,488	0.53	
C_4		210	1.1	1,769	0.63	
iC_4		57	0.3	534	0.19	
nC_4		76	0.4	702	0.25	
C_5-400° F	56.0	1,755	9.2	19,319	6.88	6.283
Fuel Oil, 300 Cs @ 210° F	8.6	17,172	90.0	252,720	90.00	8.412
		19,633	102.9	280,800	100.00	

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PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XV

ESTIMATED ISOMAX YIELDS

Charge	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lbs/Gal
Vacuum Gas Oil	19.9	14,220	100.0	193,680	100.0	7.783
H_2 (Chemical)				6,585	3.4	
				200,265	103.4	
Yields						
H_2S				2,905	1.5	
C_1				1,162	0.6	
C_2				1,162	0.6	
C_3				3,680	1.9	
C_4		1,095	7.7	9,103	4.7	
C_5/C_6		1,962	13.8	19,174	9.9	
C7/400° F		6,939	48.8	80,377	41.5	
400-625° F	33	6,513	45.8	82,702	42.7	
Total		16,509	116.1	200,265	103.4	

Properties of Products

	C_5/C_6	C7-400° F
F-1 Octane, Clear	80	56
+3cc.	97	79

E 1609

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XVI

ESTIMATED B.T.U. [illegible]

Charge	°API	B/D	Vol.%	Lbs/Hr.	Wt. %	[illegible]
Refined Virgin 150-270°F	62.0	5,100	56.54	54,2[illegible]	56.57	[illegible]
[illegible] 265-370°F	63.4	810	8.97	8,562	8.93	[illegible]
Light [illegible]	62.0	3,100	34.48	33,020	34.50	[illegible]
		9,020	100.00	95,931	100.00	

Yields

H_2			1,477	1.54
C_1			259	0.27
C_2			1,180	1.23
C_3	372	4.12	2,753	2.87
C_4's	537	5.95	4,451	4.64
C_5's	494	5.48	4,451	4.64
C_6 Paraffins	1,254	13.90	11,953	12.46
C_7 Paraffins	1,214	13.46	12,391	[illegible]
C_8 Paraffins	941	10.43	9,555	9.96
C_9 Paraffins	327	3.63	3,386	3.53
Methyl Cyclopentane	184	2.04	1,995	2.08
Cyclohexane	26	0.29	267	0.28
C_7 Naphthenes	105	1.16	1,161	1.21
C_8 Naphthenes	44	0.49	499	0.52
C_9 Naphthenes	26	0.29	288	0.30
Benzene	390	4.32	4,950	5.16
[illegible]	1,102	12.22	13,795	14.39
C_8 Aromatics	1,227	13.60	15,212	15.86
C_9+ Aromatics	487	5.40	6,188	6.45
	8,720	96.78	95,931	100.00

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PROCESSING AND ECONOMIC DATA
FOR A PROPOSED PUERTO RICO REFINERY

TABLE XVII

ESTIMATED UDEX YIELDS

Charge

Depentanized Platformate - See Table
Estimated B-T-X Platforming Yields

Yields

Extract

Platforming Yields, B/D		Recovery Factors	Recovered
Benzene	390	99%	386
Toluene	1,102	96%	1,058
C8 Aromatics	1,227	90%	1,104

Raffinate

C6 Paraffins	1,254
C7 Paraffins	1,214
C8 Paraffins	941
C9+ Paraffins	327
Methyl Cyclo-pentane	184
Cyclohexane	26
C7 Naphthenes	105
C8 Naphthenes	44
C9 Naphthenes	26
Benzene	4
Toluene	44
C8 Aromatics	123
C9+ Aromatics	487

General Properties of Raffinate

F-1 Clear	62.0
F-1 +3cc.	80.0
RVP	3.5

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XVIII

ESTIMATED HEAVY NAPHTHA PLATFORMING YIELDS

Charge	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lbs/Gal
Unifined Virgin 270-450° F	45.4	7,680	57.21	89,507	57.30	6.660
Unifined Visbrkr. 270-400° F	50.2	945	7.04	10,759	6.89	6.483
Heavy Isomaxate	45.4	4,800	35.75	55,942	35.81	6.660
	45.8	13,425	100.00	156,208	100.00	

Yields

H_2			1,968	1.26
C_1			3,452	2.21
C_2			4,421	2.83
C_3			5,967	3.82
C_4's	772	5.75	6,483	4.15
C_5's	765	5.70	7,014	4.49
Hexanes+	10,341	77.03	126,903	81.24
	11,878	88.48	156,208	100.00

Deprop. Bottoms - C_4+ Platformate

	B/D	°API	RVP	F-1 Cl.	F-1+3cc.
Total Bottoms	11,586	42.1	6.07	94.9	99.8

Platformate Split

	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lbs/Gal
C_4-390° F Platf.	48.8	9,653	83.3	110,384	80.23	6.534
390 E.P. Platf.	15.0	1,933	16.7	27,205	19.77	8.044
	42.1	11,586	100.0	137,589	100.00	6.786

E 1612

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XIX

ESTIMATED NAPHTHALENE HYDEAL YIELDS

Charge	°API	B/D	Vol.%	Lbs/Hr	Wt. %	Lb/Gal
Hvy. Platformate	15.0	1,933	100.0	27,205	100.0	8.044
H_2(710 SCF/100#)	-	-	-	1,027	3.78	-
				28,232	103.78	
Yields						
Benzene	28.3	546	28.3	7,074	26.00	7.377
Naphthalenes				11,430	42.00	
Hvy. Aromatics	31.0	65	3.3	817	3.00	7.251
Fuel Gas(methane)				8,918	32.78	
				28,239	100.00	

Fuel Gas*- 1,840 bbl F.O.E.

*Fuel gas containes components both from Hydeal operations and the heavy naphtha Platformer separator gas.

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XX

ESTIMATED GAS CONCENTRATION UNIT YIELDS

	Crude Lbs/Hr	Hvy.Nap. Platf. Lbs/Hr	B-T-X Platf. Lbs/Hr	ISOMAX Lbs/Hr	Visbkr. Lbs/Hr	Total Lbs/Hr	Fuel Gas Lbs/Hr	BTU/Lb	Recovered Lbs/Hr	Recovered B/D
H_2	-	37	23	-	28	88	88	61,029	-	
C_1	-	401	27	1,162	899	2,489	2,489	23,886	-	
$C_2^=$	-	-	-	-	365	365	365	23,859	-	
C_2	-	1,802	440	1,162	1,207	4,611	4,611	22,225	-	
$C_3^=$	-	-	-	-	1,151	1,151	173	21,047	978	128
C_3	2,890	4,038	1,831	3,680	1,488	13,927	2,089	21,664	11,838	1,597
$C_4^=$	-	-	-	-	1,769	1,769	35	20,766	1,734	196
iC_4	222	313	343	5,917	534	7,329	11	21,239	7,318	890
nC_4	510	383	238	3,186	702	5,019	14	21,301	5,005	588
	3,622	6,974	2,902	15,107	8,143	36,748	9,875		26,873	3,399

Recovery Factors

C_3's 85%
C_4's 98%

Fuel Gas: 660 bbl F.O.E.

E 1613

E 1613

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XXI

ESTIMATED GASOLINE POOL

Components	B/D	Vol. %	F-1 Cl.	F-1+3cc	RVP
Lt. St. Run	3,404	26.1	78.5	96.0	20.00
C_4-390° F Platformate	9,653	73.9	92.5	98.6	5.50
	13,057	100.0	88.4	98.0	10.0

T.E.L. requirement to meet pool octane of 95.7 = 1.2cc T.E.L./Gal

PROCESSING AND ECONOMIC DATA

FOR A PROPOSED PUERTO RICO REFINERY

TABLE XXII

ESTIMATED H_2 PRODUCTION AND CONSUMPTION

Production

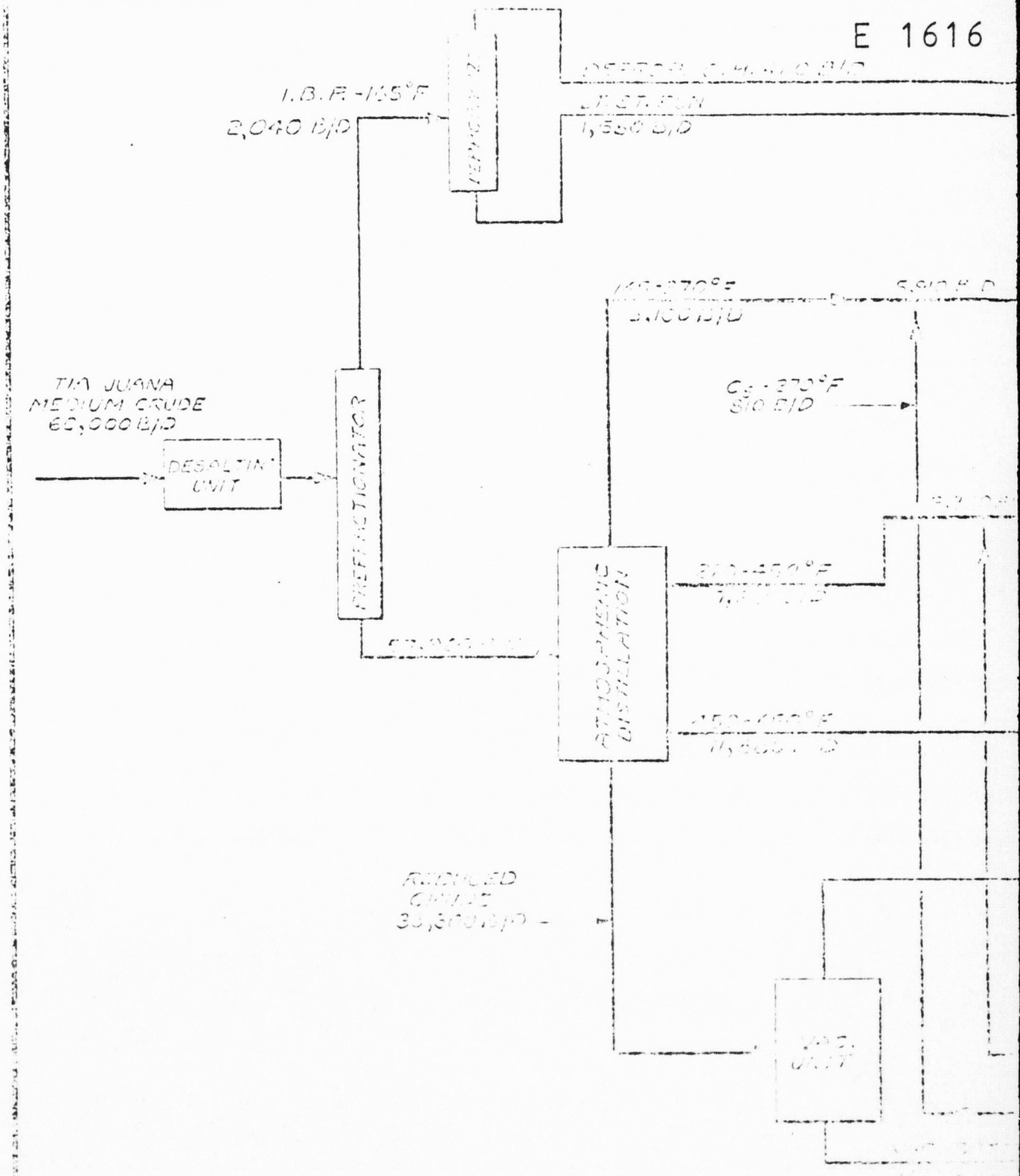
B-T-X Platformer	9,020 B/D x 729 SCF/Bbl	=	6.6 x 10^6SCF/D
Hvy. Nap. Platformer	13,380 B/D x 647 SCF/Bbl	=	8.7 x 10^6SCF/D
Hydrogen Plant		=	30.0 x 10^6SCF/D
			45.3 x 10^6SCF/D

Consumption*

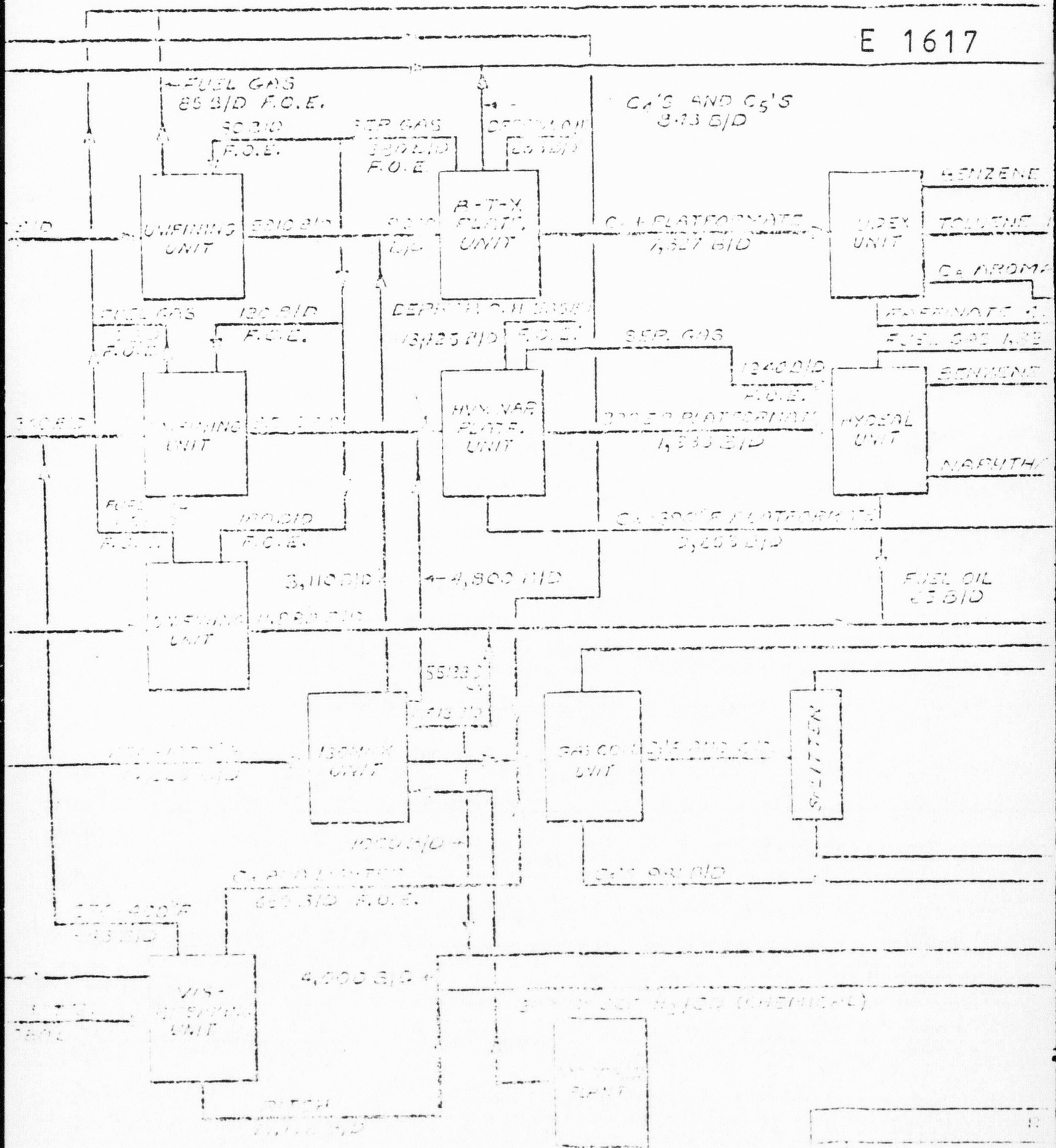
Lt.Nap.Unifiner	5,910 B/D x 108 SCF/Bbl	=	0.6 x 10^6SCF/D
Hvy.Nap.Unifiner	8,580 B/D x 117 SCF/Bbl	=	1.0 x 10^6SCF/D
No.2 F.O.Unifiner	11,880 B/D x 126 SCF/Bbl	=	1.5 x 10^6SCF/D
Hydeal Unit	1,933 B/D x 4498 SCF/Bbl	=	8.7 x 10^6SCF/D
Isomax Unit	14,220 B/D x 2150 SCF/Bbl	=	30.6 X 10^6SCF/D
			42.4 x 10^6SCF/D

*Consumption includes chemical and solution losses.

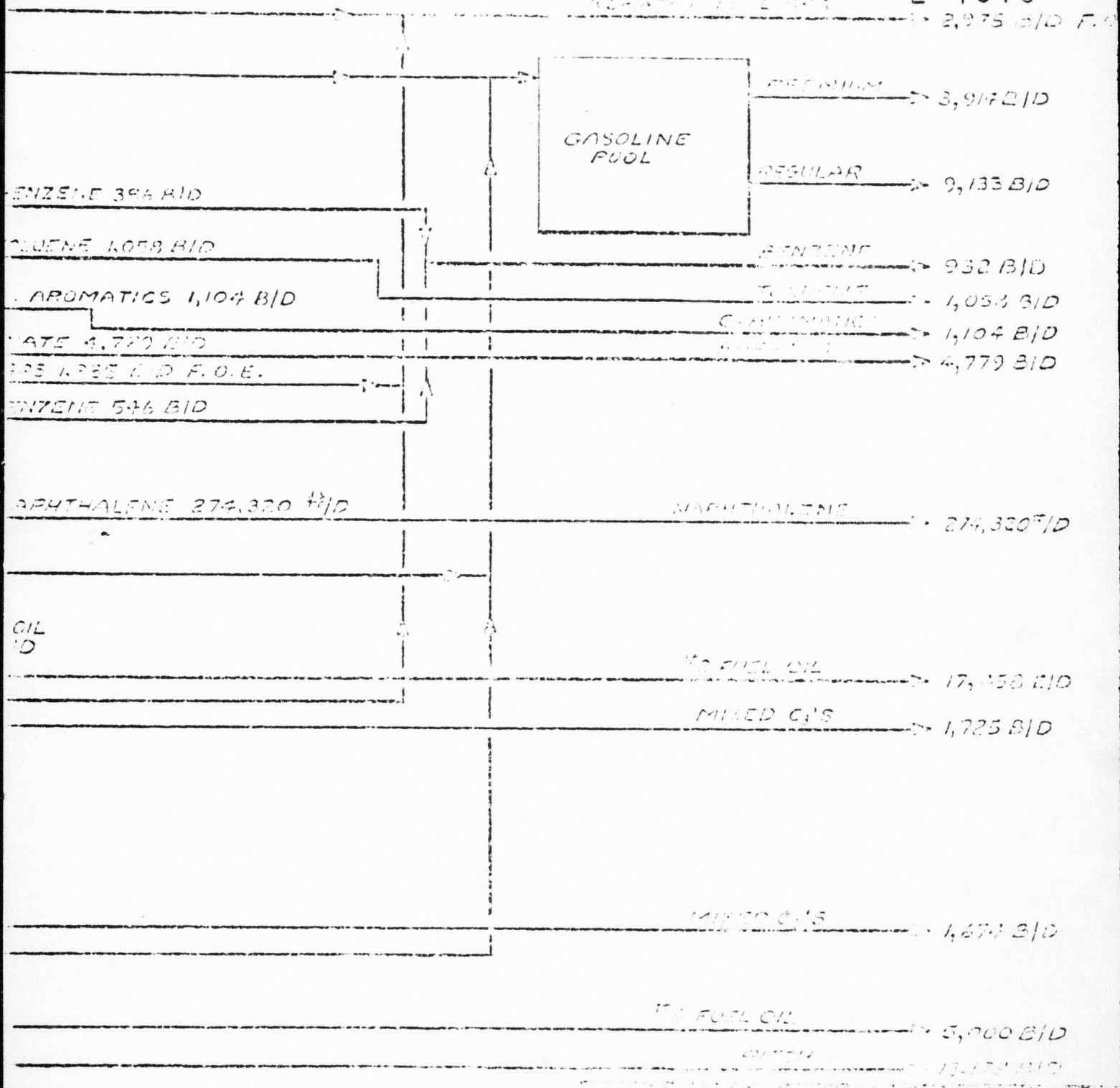
E 1616


I.B.P.-165°F
2,040 B/D
TIA JUANA
MEDIUM CRUDE
60,000 B/D
DESALTING
UNIT
PREFRACTIONATOR
ATMOSPHERIC
DISTILLATION
REFORMED
GASOLINE
30,300 B/D -

E 1617


FUEL GAS
85 B/D F.O.E.
C4'S AND C5'S
3.13 B/D
UNIFINING UNIT
B-T-X PLATF. UNIT
C6 + PLATFORMATE
1,527 B/D
UDEX UNIT
BENZENE
TOLUENE
C8 AROMA
RAFFINATE
HYX. VAR PLATF. UNIT
HYCOAL UNIT
SENTINE
NAPHTHA
FUEL OIL
23 B/D
ISOMAX UNIT
GAS CO UNIT
SULFUR
VIS-BREAKER UNIT
SPENT

E 1618



REVISIONS				CHK'D
DESCRIPTION				DATE

BLOCK FLOW DIAGRAM
OF
PROPOSED
(UNSHOCK CASE)

E 1619

PUERTO RICO PORTS AUTHORITY

SAN JUAN, PUERTO RICO

FINAL REPORT

AN INVESTIGATION OF ON-SHORE AND OFF-SHORE PHYSICAL FEATURES OF POTENTIAL PORT SITES

PUERTO RICO

TA LIANG, CONSULTANT
ITHACA, NEW YORK

December, 1960

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E 1620

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PART I GENERAL

Acknowledgement

The writer takes pleasure in acknowledging his appreciation of the general guidance provided by Mr. Rafael L. Ignacio and Dr. Salvador M. Padilla, respectively Chief Planner and Accelerator of the Puerto Rico Ports Authority, throughout this investigation. Mr. Arturo Lamadrid of the Ports Authority coordinated the work and rendered numerous services during the early studies, both in the office and in the field; his unfailing efforts are especially appreciated. Mr. Jesús R. Bascarón coordinated the work and provided competent assistance during the final stage of this investigation.

Many engineers and officials generously extended their assistance and cooperation during the investigation of various sites throughout the Island. They included: Mr. Artemis Segarra and Mr. Froilán Garcia of the Planning Division, Puerto Rico Ports Authority; Mr. E. Gracia, Consultant, and Mr. A. Dauway, Chief Engineer of the Puerto Rico Ports Authority; Mr. Rafael Seijo, and Mr. William Gahagan, respectively Chief Engineer and Resident Engineer, Gahagan Overseas Dredging Company, San Juan; Captain Angel Maldonado, Port of Fajardo; Mr. José H. Martinez, U. S. Department of Agriculture Officer, Fajardo; Representative Enrique J. Andrade of Aguirre; Mr. Ernesto Ruiz, Ponce Port Supervisor; Mr. M. A. Sastre of Mercedita Central; Mr. Pedro L. Vivas, Geologist, Ponce; Captain Oscar Padilla, Port of Guayanilla; Captain William Suarez, Port of Guánica; Mr. Thomas W. Crump, President, Star-Kist Caribe, Inc.; and Mr. Ismael R. Muñoz, Resident Engineer, Mayaguez.

Mr. Ernesto A. Pinero and Mr. Zenon Mercado, of the Puerto Rico Department of Public Works, graciously cooperated in the procurement of aerial photographs and topographic maps covering the sites.

Several specialists had contributed their expert advice in New York during this investigation. They included: Dr. N. A. Christensen on sedimentation; Dr. C. H. Yen on port location, and Professor B. K. Hough on subsurface exploration.

Publications and reports consulted during this investigation are listed under the section of "Selected Bibliography" in this report.

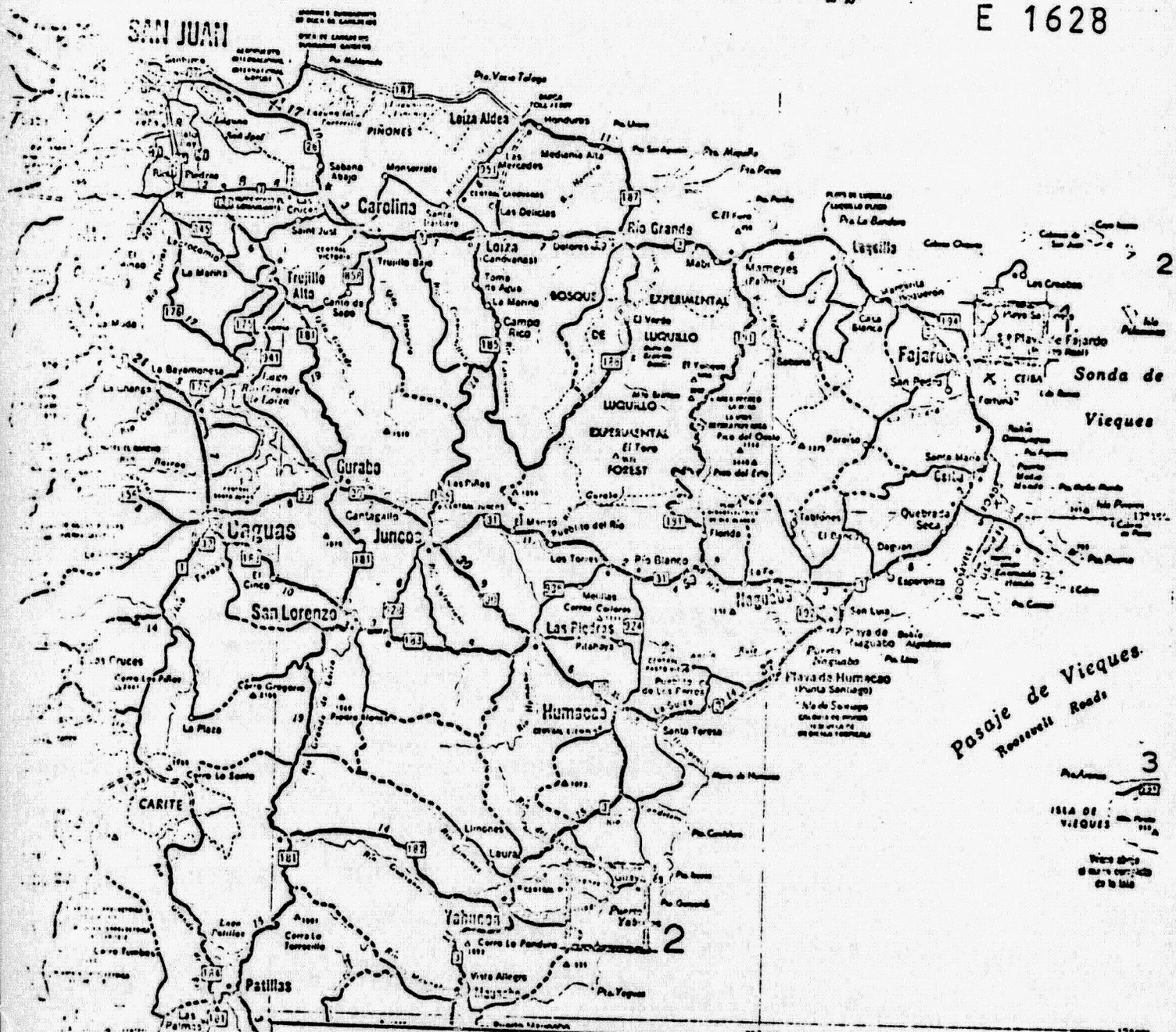
E 1625

1. Authority and Scope:

This investigation of physical features of potential port sites was authorized by a professional service contract between the Puerto Rico Ports Authority, San Juan, Puerto Rico, represented by its Executive Director Mr. Rafael Durand, and Dr. Ta Liang, Consultant, Ithaca, New York dated November 1, 1959, which was subsequently extended to include several additional sites by an addendum of the contract, dated February 18, 1960. This investigation includes the study of on-shore and off-shore soil and geological conditions and related physical features of all sites; it was performed by a review of aerial photographs, topographic, soil and geologic maps, and other pertinent reference materials, and a field reconnaissance. Site locations are shown in Plate I.

A
B
C
O C E A
11
10
9
8
7
6
5
Isabela
Aguadilla
Bahía de Aguadilla
Aguada
Bahía de Añasco
Quebradillas
Camuy
Hatillo
Pueblito de Ponce
GUAJATACA
Pueblo Nuevo
Barranca
Las Cuevas
El Coco
El Paisil
La Cuesta
El Saco
Bayaney
La Esperanza
Dominguito
Chuco Hondo
Los Lanceros
San Sebastián
Lares
Angeles
Las Marías
Maricao
Rosario
Normizuelas
Joyuda
La Parra
Corcho Rojo
Palmarejo
Laja
Sabana Grande
Yauco
Peñuelas
Guayanilla
Ensenada
Guánica
Bocueron
Cabo Rojo
Adjuntas
Villa Pérez
Los Ranchos
Monte Membrillo
Monte Guilarte
GUILARTE
Pico Redondo
Pico Santo Ana
Pico Jagua
Pico Alegrillo
Cerro Alegrillo
Cerro Palmer
Cerro Morrillo
Cerro Torre
Cerro Yaurero
Cerro Vaquero
Cerro Avispa
Cerro de los Bueyes
Cerro Arenas
Cerro Buena Vista
Cerro Avispa

N
A T L A N T I C
E 1627
Palmas Altas
Barceloneta
Manatí
Vega Baja
Vega Alta
Toa Baja
Toa Alta
Bayamón
Corozal
Morovis
Naranjito
Comerío
Aguas Buenas
Cidra
Aibonito
Cayey
Coamo
Juana Díaz
Villalba
Orocovis
Ciales
Florida
Arecibo
Utuado
Jayuya
Adjuntas
Ponce
Peñuelas
Guayanilla
Yauco
Guánica
Lajas
Sabana Grande
Guayama
Arroyo
Patillas
Maunabo
Humacao
Naguabo
Río Grande
Luquillo
Fajardo
Ceiba
Culebra
Vieques
Isla Caja de Muertos
Cayo Berbería
Playa Cortada
Playa Santa Isabel
Pta. Petrona
Pta. Cabullón
Pta. Cortezo
Pta. Cabo
Río Grande de Arecibo
Río Cibuco
Río Camuy
Río Tanamá
Río Arecibo
Río Grande de Manatí
Río Bayamón
Río Cañas Arriba
Río Jueyes
Río Portugués
Río Descalabrado
Río Nigua
Río Matrullas
Río Inabón
Río Jacaguas
Río Toa Baja
Río Toa Vaca
Río Grande de Loíza
Río Canóvanas
Río Gurabo
Río Valenciano
Río Turabo
Río Guamaní
Río Jacaguas
Río Nigua
Río Descalabrado
Río Jueyes
Río Cañas Arriba
Río Portugués
Río Grande de Arecibo
Río Cibuco
Río Camuy
Río Tanamá
Río Arecibo
Río Grande de Manatí
Río Bayamón
Río Toa Baja
Río Toa Vaca
Río Grande de Loíza
Río Canóvanas
Río Gurabo
Río Valenciano
Río Turabo
Río Guamaní
Río Inabón
Río Matrull



TA LIANG - CONSULTANT
ENGINEERING INTERPRETATION
OF AERIAL PHOTOGRAPHY
ITHACA, NEW YORK

PUERTO RICO PORTS AUTHORITY, SAN JUAN, P.R.

PORT SITES INVESTIGATION

LOCATION MAP

ESSO MAP DEC 1960 PLATE I of XII

CENTRALES AZUCARERAS
SUGAR MILLS

Aguirre F-4	Guánica C-4	Plata B-2
Canóvanas D-2	Igualdad B-2	Plazuela D-2
Carmen C-2	Juncos F-2	Río Lajas C-2
Central B-2	Juncos G-3	Rufina B-2
Constancia E-2	Lafayette F-3	Soll C-3
Corneta C-4		Suiza C-1

E 1629

2. Summary of Work:

Immediately upon signing of the contract in November 1959, office study was started in New York. Reference materials were obtained from both Washington and San Juan. Aerial photographs were secured from the Puerto Rico Department of Public Works (1:15,000 scale; 1951 series), as well as from the Mark Hurd Aerial Survey Corporation of San Juan (1:4800, 1959 series).

Field investigation was undertaken during the weeks of January 25 and February 1, 1960. During the first week, the consultant was accompanied by Mr. Arturo Lamadrid of the Ports Authority; during the second week, Mr. Froilán Garcia of the Ports Authority also joined the field party. During this field investigation, all the proposed sites were visited, except Fajardo which was subsequently visited during a brief trip in August 1960.

In addition to these ground investigations, the consultant was fortunate to have an opportunity, in the summer of 1959, to fly over the coastal areas in a light plane to observe the physical conditions of most of the port sites described in this report. This air trip was made with Dr. Salvador Padilla, then Chief Planner of the Ports Authority; the trip proved to be most helpful in this investigation.

During the visits to each site, besides first-hand observations of physical conditions, local people were inquired of their experience including wind speed and direction, wave heights and floods. Harbor officials, engineers and geologist were interviewed whenever possible. After the return of the field party to San Juan, technical people from various organizations were further consulted and valuable information obtained and incorporated into this report.

With the wealth of information gathered from photos, maps and other sources it is believed that the general soil and geological conditions, particularly in on-shore areas, are sufficiently clear for the purpose of a preliminary study of port locations. Thus, a preliminary

E 1630

report including a series of maps showing physical conditions of all sites was prepared and submitted in April 1960 for discussion. Accordingly, a conference between the officials of the Ports Authority and the consultant was held in San Juan during August 1960 to discuss the details for production of this final report.

The desirability of a boring program had been discussed during this investigation. It was felt that a limited boring program at this stage may add some information to the offshore conditions, but probably would not change the overall perspective. Therefore, the submission of this final report will not await the field borings. Rather, all the preferred sites and suggested boring areas are indicated in this report. When a detailed study is to be undertaken in particular sites in the future, a systematic boring program guided by the general information herein given should be executed prior to design and construction.

E 1631

3. Method of Investigation:

A. On-Shore Areas. An extensive study of the topographic maps, geological and soil maps of each port area is the first step. This is then followed by a careful analysis of the small and large scale aerial photographs. The small scale photos provide overall perspectives whereas the large scale photos show detailed features, complementing each other.

All aerial photographs are studied with a stereoscope to give a three-dimensional view. The topographic, drainage and erosion patterns, vegetation, and gray tones on the photos are examined to determine the rock and soil types. Tentative rock and soil boundaries are drawn on photographs and then transferred to maps. These boundaries are subsequently checked against field observations and subsurface information obtained from various sources. Finally, the map is revised to its final form after a restudy of all pertinent reference material.

The map units that delineate the various rock and soil types are tailored to the anticipated requirements of port site developments. They generally indicate the depth of overburden, the type of soil or rock regarding drainage and excavating characteristics, slope stability, and bearing capacity for buildings and structures. Water table and flooding possibility are also considered.

In mapping the soils, direct recognition of features on photos and from field observations as well as inference guided by established scientific principles are fully utilized. Soil forming processes, transportation and deposition of soil through actions of streams and waves, and influence of ecologic environment are all taken into consideration.

B. Off-Shore Areas. The off-shore conditions presented in this report are derived from a careful study of hydrographic charts, airphoto patterns, local information from engineering personnel and estimates based on principles of sedimentation. It must be stated clearly that while on-shore soil conditions are generally well-defined on airphotos, off-shore features are much less so, and therefore should be considered relatively not as accurate.

The study of each site begins with a careful comparison of hydrographic charts and corresponding airphotos. Tentative conclusions of the off-shore conditions are drawn and maps compiled delineating areas of rock, sandy soils and fine-textured soils. The areas having water depths greater than thirty feet are considered adequate for navigation; they are so indicated and excluded from further study in this investigation. The mapping boundaries are then checked against other available information as well as conclusions deduced from a study of the sedimentation process. Some of the highly uncertain areas are designated by question marks after the map units or shown with dotted boundaries, indicating a need of field confirmation should these areas be considered seriously for future construction.

In spite of the uncertainty of the accuracy of off-shore features in some areas, it is believed that the maps are essentially dependable and indicative of the prevailing general conditions which are required at this stage. Because of the vastness of the areas covered, it would not be economically justifiable to go into a detailed boring program. Scattered borings may not add much to what is now known and they would not alter the present conclusions significantly.

4. Physical Factors Affecting On-Shore Soils: E 1633

A. Geology. This investigation relies heavily on a careful analysis of the geological process operating in the past as well as present. The Island of Puerto Rico has a central east-west core of mountain ranges composed of a complex of volcanic and sedimentary rocks, some metamorphosed. Intrusive rock hills are found in scattered areas; the granites in Yabucoa and in Utuado areas are the major ones. There are two belts of recent limestone hills: one along the north coast, and the other the southwest coast. Talus slopes and alluvial cones and fans are located between the hills and the flat lands. The latter consists of coastal plains, flood plains, beach sands, beach ridges, tidal flats and swamps, extending to the coast. Coral reefs and islands are common along the coasts.

The parent rock and the mode of transportation greatly influence the soil characteristics. Generally, granites and the more resistant volcanic rocks are the sources of sands and gravels whereas the less resistant volcanic rocks and limestones yield silts and clays. Natural transporting agents, water, wind and gravity, sort the materials while moving them. Water and wind leave the larger-sized materials near to the source but carry the smaller-sized to a farther destination. This principle is applicable to river deposits as well as coastal deposits where wave drops sand on the beaches and carries the fine-textured sediments toward the sea. Gravity force operates in a somewhat different manner; in talus slopes, large-sized materials fall the greatest distance to the bottom whereas small-sized materials remain close to their original position.

B. Climate. Temperature and rainfall affect soil formation and transportation. Although temperature is fairly uniform throughout the Island, the variation of rainfall is considerable from one part to the other. This has profound effects on such developments as depth of rock weathering, degree of laterization, and soil erosion. They are taken into consideration in soil classification and mapping.

C. Vegetation. Both natural vegetation and cultivation practice are closely related to the soil properties. Vegetation affects soil biologically and then itself is an accurate indicator of soil conditions such as soil texture, water table and salt and alkali contents. For instance: sugarcanes prosper in well-drained silty flat land; coconuts are best grown in sandy coastal areas where water table is more than three feet below surface; and mangrove is identified with low swampy areas. Vegetative patterns like these are well shown on airphotos. Furthermore, transitional zones between different soil areas where crops gradually fail under changing natural soil environments are often clearly discernible on photographs.

E 1635

5. Physical Factors Affecting Off-Shore Soils:

A. Source of Material. The off-shore material is either originated from inland behind the coastal area and then transported and discharged into the harbor, or originated from the outside and then carried and deposited into the harbor by ocean currents. In the first case, the material is closely related to the local on-shore soil which in turn is a product of its parent material and transportation forces. In the latter case, the material is either a weathering product of nearby coral reefs and rock headlands or sediments from other parts of the Island.

B. Currents, Winds and Waves. It is well established that the ocean currents move from east to west, and from south to north around the Island. Also, there are some seasonal eddy currents along the north coast. These currents are responsible for the transportation of the sea-bottom materials in the broadest scale.

The prevailing winds of the Island are from north and northeast. As a result, the waves are strongest on the north and northeast coasts. In contrast, the south and west coasts are relatively quiet through most of the year. The wind and wave conditions greatly influence the particle size and slope of off-shore material, growth of coral reef and beach rock, the depth of channels and the development of tidal flats and swamps. These conditions are indicated in the maps of specific port sites in this report.

6. Map Units: E 1636

A system of map units has been devised to reveal the soil and geologic conditions of both on-shore and off-shore areas. The map units are designed to provide information in a convenient way to facilitate port site planning. A description of these units follows:

A. On-shore Map Units

I. Bedrock and Residual Soils

The area is composed of either bare rock or residual soil with parent rock at varying depths. Topography is rolling to hilly. Deep excavations might encounter rock. Drainage and foundation condition is generally favorable. Certain special conditions are described under pertainent sites.

Ia. Granite

Generally sandy and silty soil with rock fragments. Well-drained but may be erodable.

Ib. Limestone

Generally clays and stoney clays with limestone at varying depths. Well-drained in natural undisturbed state.

Ic. Tuff, Tuff Breccia, Andesite and Shale

Generally friable clays and silts with rock fragments.

Id. Cemented Dunes and Sandstones

Generally shallow sandy soil and sandstone.

II. Talus, Alluvial Cones and Alluvial Fans

The area is composed of soil transported to its position by gravity or water. There is a gently to steeply sloping topography. Generally coarse-textured soils. Parent

material is at varying depth. Drainage condition is favorable. Foundation condition is good except in steep talus slopes. Certain special conditions are described under pertinent sites.

IIc. Talus (Limestone Material)

Steep slope of clay soil and limestone fragments. Larger fragments are accumulated at lower slopes.

IIa. Alluvial Cone and Fan (Granite Material)

Gentle slope of sandy to silty soil. Generally well-drained, good foundation. Material is coarser near to the head of the fan and finer toward the lower edge.

IIb. Alluvial Cone and Fan (Limestone Material)

Gentle slopes of clays and silts with some limestone fragments. Poor to moderately well-drained.

IIc. Alluvial Cone and Fan (Tuff or Shale Material)

Gentle slopes of silts, clays and rock fragments. Poor to moderately well-drained.

III. Flood Plains

The area is composed of uniform alluvial deposits. The topography is flat. Excavation is easy. Foundation and ground water condition variable depending on the following sub-units. Special conditions are described under pertinent sites.

IIIa. Silts and Generally Well-Drained Soils

Foundation and ground water conditions generally favorable.

IIIb. Clays and Generally Poorly-Drained Soils

Foundation and ground water conditions generally need special consideration. Locally salt problems.

E 1638

IV. Coastal and River Sands

The area is composed of sandy material deposited primarily by wave or river action. A few small areas of sand are deposited by wind. The topography varies from flat or gently sloping beaches to slightly undulating beach reidges and depressions. Excavation is easy. Drainage and foundation conditions are generally favorable. Certain special conditions are described under pertinent sites.

IVa. Beach Sand

Generally medium to fine sand with shell fragments, gently sloping to flat land adjacent and parallel to coast, well-drained and good foundation material.

IVb. Beach Ridges

Generally medium to fine sand with shell fragments, paralleling low ridges in coastal areas. Well-drained and good foundation soils. The depressions between ridges are filled with shallow deposits of silts, clays, and organic materials. (Some beach ridge areas are underlaid by less desirable flood plain deposits; special investigations should be undertaken for deep foundations.)

IVc. River Sand

Generally medium to fine sand, occasionally coarse sand, natural levees or river bars. Well-drained and favorable shallow foundation soils.

E 1639

V. Tidal Flats, Clays, and Swamps

The area is composed of silts, clays, salts and/or organic materials. The topography is flat. Water table is near to or at surface and the area is sometimes submerged. Poor drainage and poor foundation material. Certain special conditions are described under pertinent sites.

Va. Tidal Flats, Clays, and Swamps (Predominantly Low Land)

Vb. Tidal Flats, Clays, and Swamps (Predominantly Swamp)

B. Off-Shore Map Units

The map units designate conditions expected between sea level and a depth of about thirty feet.

A Coral reef

B Coral or other rock at shallow depths

C Fine-textured sediments (primarily silts and clays)

D Coarse-textured sediments (primarily sands)

C/A Fine-textured sediments over coral reef

D/A Coarse-textured sediments over coral reef

C/B Fine-textured sediments over rock

D/B Coarse-textured sediments over rock

C/D Fine-textured sediments over coarse-textured sediments

W Water depth greater than thirty feet

7. Conclusions and Recommendations: E 1640

A. A wealth of information regarding on-shore and off-shore physical features is available through a study of existing maps, charts, airphotos and a field reconnaissance.

B. The information is summarized in a series of maps in Part II of this report covering all sites proposed by the Ports Authority. All maps are prepared at the same scale of 1:20,000 to facilitate comparison. They will provide an overall perspective of each site as a basis for systematic planning.

C. The advantages as well as disadvantages of each site are discussed in detail in Part II of this report. Potentially good locations for development in each site are also designated therein. The overall conditions of those sites having relatively favorable physical features are listed below:

Port Sites	Remarks
2. Yabocua	Favorable on-shore and off-shore conditions
4. Cabulión and Ponce	Generally favorable; some coral and mud off-shore
5. Guayanilla	Generally favorable; some coral and mud off-shore
6. Guánica	Favorable on-shore and off-shore conditions
9. Mayagüez	Generally favorable; limited on-shore area
10. Añasco	Favorable on-shore and off-shore conditions

D. This report has to be relatively brief because of the size of areas covered. When future detailed study of specific sites warrants, a somewhat more detailed and refined information concerning pin-point locations could be obtained by a further review of the voluminous existing reference materials.

E 1641

E. At this preliminary stage, a general subsurface investigation is not considered justifiable because it would not serve the useful purpose of increasing our present knowledge of the overall port conditions. A limited exploration program is suggested in certain locations as indicated on the maps of several sites in case those areas have to be considered seriously. Finally, a systematic probing and boring program should be undertaken to facilitate detailed designs when a project location becomes more well defined and limited to a smaller area.

E 1642

8. Selected Bibliography*:

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*Note: Certain references pertaining to individual sites are listed under the description of each site.

PART II SPECIFIC SITES

E 1644

1. Fajardo

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale and 1:4,800 scale airphotos, 1:10 000 scale hydrographic chart; field reconnaissance, and communications from Mr. A. Dauway, Puerto Rico Ports Authority.

The on-shore area consists of hills as well as flat land. The hills are of tuffaceous shales and andesitic agglomerates and their residual soils. The flat land is composed of moderately well-drained fan and flood plain soils; there are also clays, swamps with high water table and some beach sands immediately adjacent to the coast.

The land area is relatively limited for development. North of the Rio Fajardo the hills extend to the water front in many places and the existing town occupies a major portion of the favorable flat ground. South of the river, low swampy land predominates although better soils are available inland.

Off-shore, the port is well protected from waves by reefs and islands. However, these protections together with the river deposition have resulted in an accumulation of deep fine-textured sediments in the harbor. It appears that considerable dredging of mud, with some sand and rock, would be necessary in developing this site.

In summary, the overall physical condition is not favorable because of the limited on-shore area and the continous deposition of mud by the river. Detailed information is shown in the accompanying map, Plate II.

E 1645

Plate II Fajardo

Condensed Legend

E 1646

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
a Granite	Variable	Good	Good
b Limestone	Variable	Good	Good to Fair
c Tuff, Shale	Variable	Fair	Fair
d Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
a Talus	Easy	Good	Poor
b Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
b Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
a Silts and well-drained Soils	Easy	Good	Good to Fair
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
a Beach Sand	Easy	Good	Good
b Ridge Sand	Easy	Good	Good
c River Sand	Easy	Good	Good to Fair
Wet Area			
a Low land	Easy to Medium	Fair to Poor	Poor
b Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Note: 1. For a more detailed description, see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

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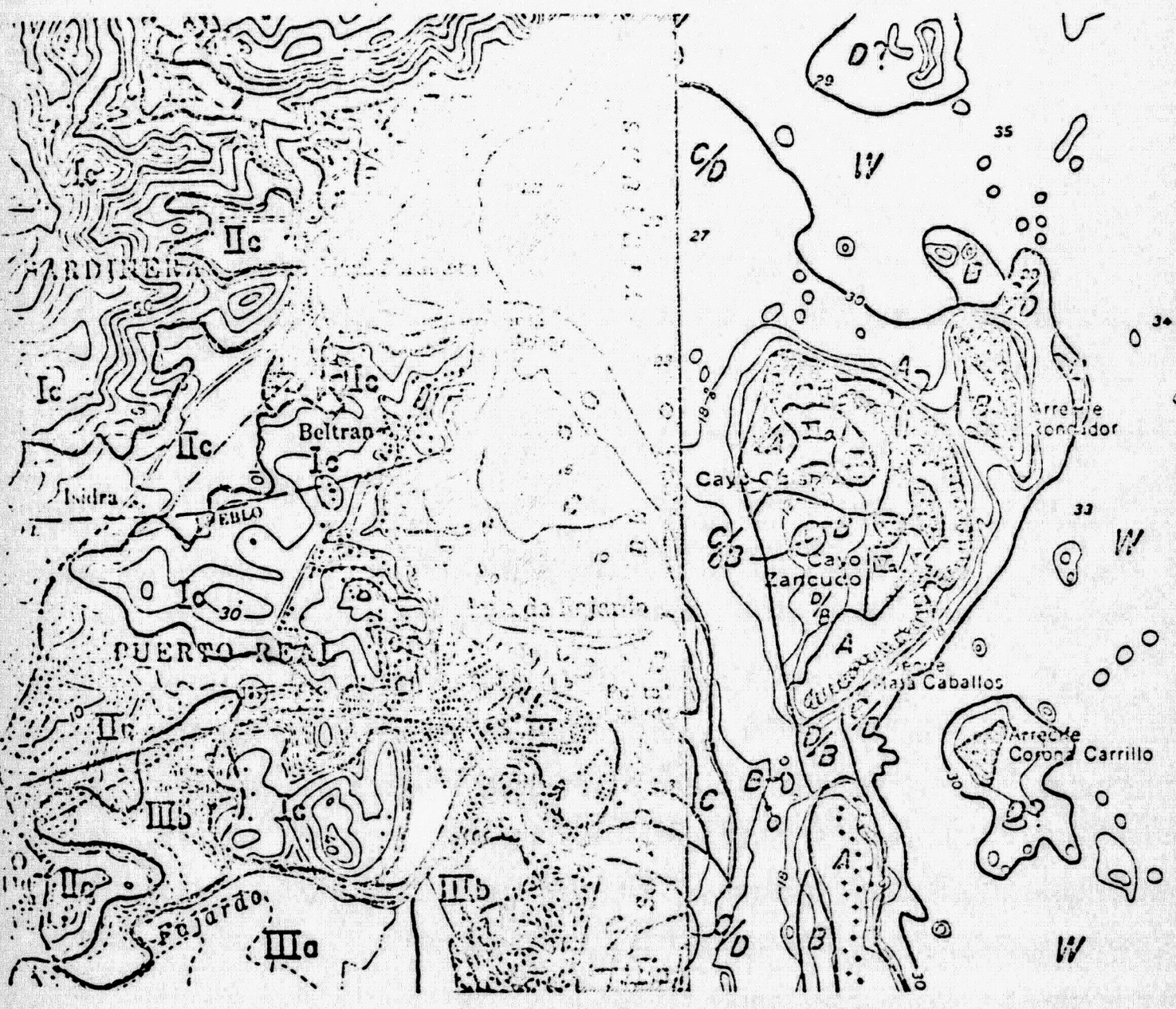
E 1647



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PORT SITES INVESTIGATION

I. FAJARDO

SCALE 1:20000 DEC 1960 PLATE II of [illegible]

E 1648

2. Yabucoa

Sources of information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:10,000 scale hydrographic chart; field reconnaissance.

The on-shore area consists of an extensive flat land bounded by granitic hills both on north and south. The granite hills are primarily responsible for the coarse-textured soils in this region. The flat land includes the sandy beach and beach ridges along the coast and the broad flood plain of sandy and silty soils immediately inland. The sandy soils are generally satisfactory for borrow material as well as for foundations. Thus, both from topographic and engineering soils considerations, the land area is favorable for development.

Off-shore, the port is fairly well-protected by islands, yet the wave is vigorous enough to carry away most of the fine-textured sediments. It appears that most of the dredged material required would be sandy; small quantity of rock is expected in scattered locations.

In summary, the site is generally favorable both from on-shore and off-shore considerations. Detailed information as well as potential development area are indicated in the accompanying map, Plate III.

E 1649

Plate III Yabucoa

Condensed Legend*

E 1650

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
IIb Talus	Easy	Good	Poor
IIa Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
IIb Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
IIc Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
Silts and well-drained Soils	Easy	Good	Good to Fair
IIIa over granular soils	Easy	Good	Good
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
Va Beach Sand	Easy	Good	Good
Vb Ridge Sand	Easy	Good	Good
Vc River Sand	Easy	Good	Good to Fair
Tidal Area			
Low land	Easy to Medium	Fair to Poor	Poor
Swamp	Medium to Difficult	Poor	Very Poor
Vb* Peat and organic soils	Medium	Poor	Poor

Off-Shore Features

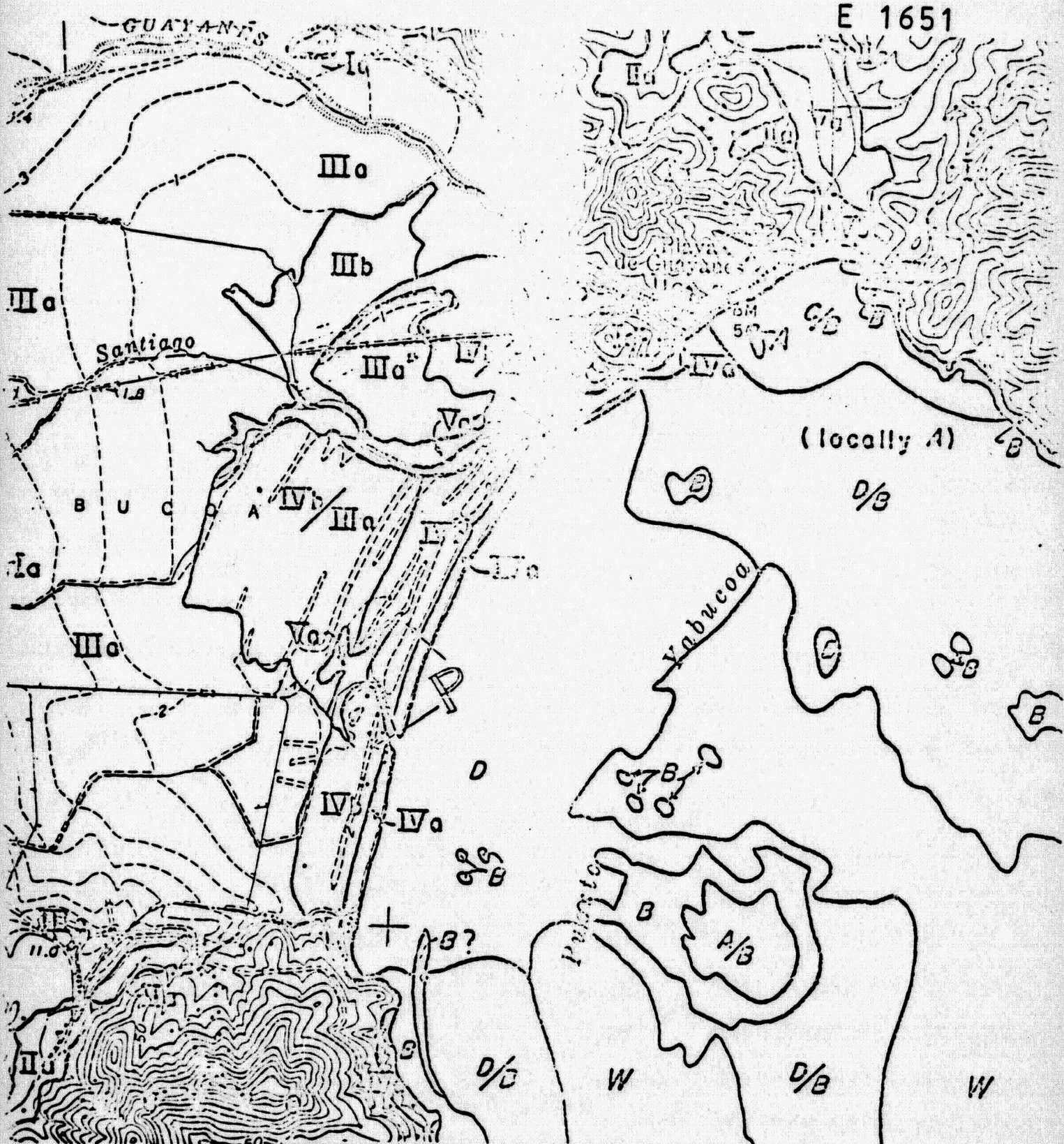
A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development

Note: 1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

E 1651



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PORT SITES INVESTIGATION

2. YABUCUA

SCALE 1:20000 DEC 1960 PLATE III of XIII

3. Jobos and Aguirre E 1652

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:20,000 scale hydrographic chart; field reconnaissance, and communications from Gahagan Overseas Dredging Company.

The on-shore area consists of fan and flood plain soils with extensive swamps, salt flats and some beach sands along the coast. There is an igneous rock hill situated directly west of the town of Central Aguirre.

Off-shore, the area is well protected from waves by coral islands. Conditions of sediments are variable; the sediments are generally deep and poor.

The Jobos Bay is very shallow, filled with fine-textured sediments. Most of the Bay is surrounded by low, swampy land except at Point Pozuelo area where extensive beach sand developed. Because of its sandy soil and favorable approach from sea, Point Pozuelo area itself might provide a good possibility for development and is so indicated in the accompanying map.

In Central Aguirre, the on-shore topography varies from rolling to hilly; the harbor is muddy but becomes more sandy toward the sea. Between the harbor and the sea, there is a chain of coral islands with patches of sand on top of them.

West of central Aguirre, there is an extensive area of swamps and salt flats, although a narrow band of beach sand developed along the coast. Mud and some rock are expected directly off-shore. A relatively deep sandy channel is reported between these mud areas and the coral chain toward the sea. Development along the coastal area at Mar Negro and vicinity is a possibility. If such a development is contemplated, a limited probing to ascertain bay bottom conditions directly adjacent to shore would be desirable. This area is also indicated in the accompanying map.

In summary, the overall physical condition of this general area is not favorable because of the swampy low land on-shore and the deep mud bottom off-shore. However, if because of economic reasons, serious consideration for port development is required in this location, then the Point Pozuelo and Mar Negro areas should be further explored and a limited probing program executed. Detailed information is shown in the accompanying map, Plate IV, which also indicates potential port and probing locations.

E 1654

Plate IV Jobos and Aguirre

Condensed Legend*

E 1655

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
IIa Talus	Easy	Good	Poor
IIb Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
IIc Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
IId Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
IIIa Silts and well-drained Soils	Easy	Good	Good to Fair
IIIb* Silt over granular Soils	Easy	Good	Good
IIIc Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
IVa Beach Sand	Easy	Good	Good
IVb Ridge Sand	Easy	Good	Good
IVc River Sand	Easy	Good	Good to Fair
IVd* Shallow silt over granular Soils	Easy	Good	Good to Fair
Tidal Area			
Va Low land	Easy to Medium	Fair to Poor	Poor
Vb Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
x General Location for Limited Probing Program

* Note: 1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow .

E 1656

4. Cabulión and Ponce

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale and 1:4,800 scale airphotos, 1:20,000 hydrographic chart; field reconnaissance, Central Mercedita soils reports by Mr. R. Frann and by Foundation Company of Puerto Rico and communications from Mr. A. Dauway, Puerto Rico Ports Authority.

The on-shore area consists of a broad flood plain of well-drained silts and an extensive beach ridges deposit of sands parelleling the coast. There are minor swampy areas.

Off-shore, the area is protected by a series of coral reefs. Sediment conditions vary within short distances as indicated on the map. Mud bottoms are located behind reefs, close to river mouths and swamps or other quiet water zones whereas sand bottoms are found close to beachs and areas where wave action is strong. Submerged corals are encountered in scattered areas but would not be a major item in dredging.

Generally, the Cabullón area has favorable on-shore and off-shore features for development. Poor soil areas are warned on the map. In the Ponce port area, mud bottom and certain poor on-shore soils in its immediate vicinity have limited the development there. However, there is a possibility of developing an area east of the existing port area.

In summary, the overall on-shore and off-shore features at Cabulión are generally favorable except that there are corals and muds at certain off-shore locations. Detailed information as well as potential development areas and suggested probings are indicated in the accompanying map, Plate V.

E 1657

Plate V Cabullón and Ponce

Condensed Legen[illegible]

E 1658

On-Shore Features

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
IIa Talus	Easy	Good	Poor
IIa Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
IIb Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
IIc Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
IIIa Silts and well-drained Soils	Easy	Good	Good to Fair
IIIb Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
IVa Beach Sand	Easy	Good	Good
IVa** IVa, primarily corals and shells	Easy	Good	Fair
IVb Ridge Sand	Easy	Good	Good
IVc River Sand	Easy	Good	Good to Fair
Tidal Area			
V Low land	Easy to Medium	Fair to Poor	Poor
Vb Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

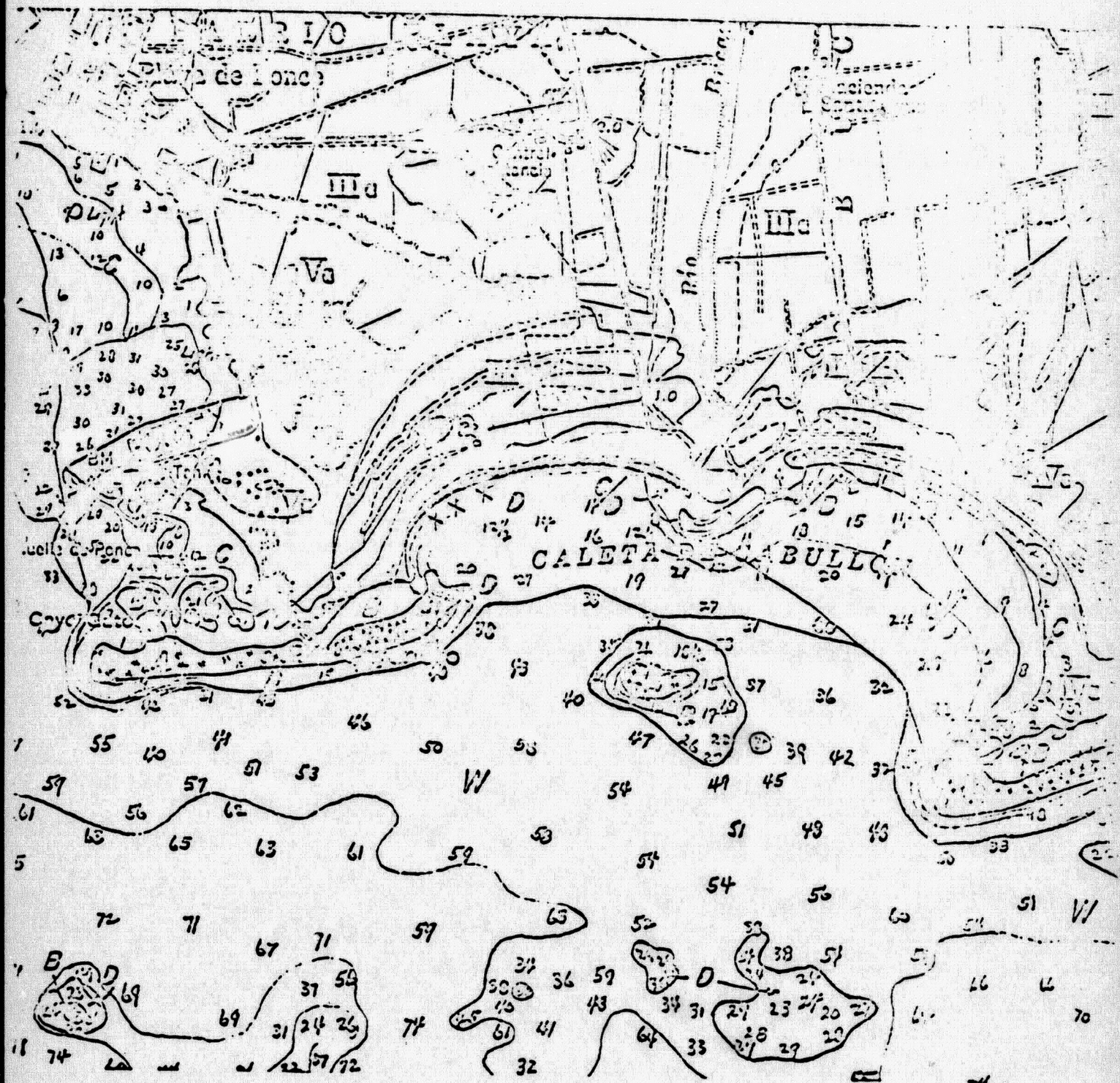
A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
x General Location for Limited Probing Program

1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

E 1659



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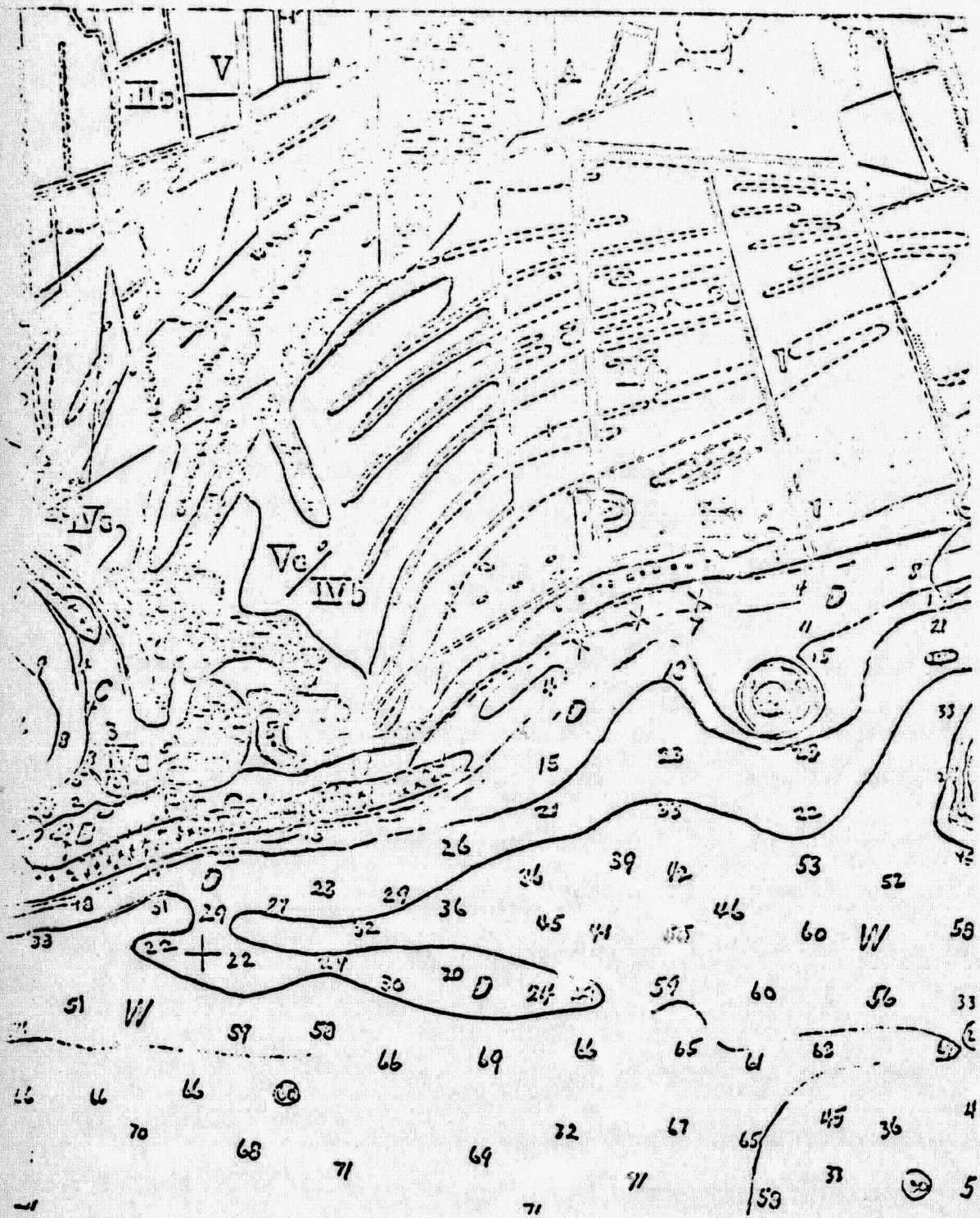
E 1660



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PORT SITES INVESTIGATION

4. CABULLÓN AND PONCE

SCALE 1:20000 DEC 1960 PLATE V of VII

BASE MAP U.S.G.S. TOPOGRAPHIC SERIES

E 1661

5. Guayanilla

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:10,000 scale hydrographic chart; field reconnaissance, communications from Gahagan Overseas Dredging Company.

The on-shore area consists of limestone hills, well-drained fans and flood plains and coastal swamps. At the east wing, Punta Guayanilla, there is a prominent development of sandy beach ridges along the coast.

The off-shore conditions are variable. In the middle portion of the harbor, where the waves are active, there is a sandy bottom. At Puerto de Guayanilla, the western bay, there is an accumulation of deep fine-textured sediments. In both the west and east outlying areas of shallow and relatively quiet waters, there are fine-textured soils overlying rock. Many coral reefs and islands scattered throughout the off-shore regions of the coast. However, navigation would not be difficult.

In summary, the area is a natural, well-protected harbor. Furthermore, both on-shore and off-shore features are generally favorable for development in the vicinity of Playa de Guayanilla and in Ponta Guayanilla area; a special point for consideration is the coral and mud deposit at certain locations off-shore. A limited probing program should be undertaken in the off-shore locations immediately adjacent to the above mentioned land areas prior to detailed planning. Detailed information and the potential development areas are shown in the accompanying map, Plate VI.

E 1662

Plate VI Guayanilla

Condensed Legend

On-Shore Features

E 1663

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
Granite	Variable	Good	Good
Limestone	Variable	Good	Good to Fair
Tuff, Shale	Variable	Fair	Fair
Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
Talus	Easy	Good	Poor
Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
Silts and well-drained Soils	Easy	Good	Good to Fair
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
Beach Sand	Easy	Good	Good
Reef, primarily corals and shells	Easy	Good	Fair
Ridge Sand	Easy	Good	Good
River Sand	Easy	Good	Good to Fair
Tidal Area			
Low land	Easy to Medium	Fair to Poor	Poor
Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
x General Location for Limited Probing Program

Notes: 1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

6. Guánica

E 1664

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale and 1:4,800 scale airphotos, 1:10,000 scale hydrographic chart; field reconnaissance, and communications from Gahagan Overseas Dredging Company and from Mr. A. Dauway, Puerto Rico Ports Authority.

The on-shore area consists of limestone hills, fans and flood plains of well- to poorly-drained soils and some swamps. There are talus slopes with relatively deep soil at the foot of certain limestone hills. Although the land is limited by hills and existing establishments, there is still ample space and reasonably good land for development.

The off-shore features are particularly favorable. There are a number of coral islands providing good protection from the sea. The harbor channel is generally deep and sandy, with the exception of the areas near to the Central and toward the end of the Bay where fine-textured soils are accumulated to great depths. There are some rocks at shallow depths in scattered areas as indicated in the map. Corals and varying sediment conditions in the outer bay areas are also indicated.

In summary, the area is a natural harbor. Both on-shore and off-shore conditions are favorable. The area at the vicinity of Playa de Guánica offers specially good possibilities. The dredged material there is expected to be sandy and could be used to fill the adjacent coastal lowland. A limited probing program in the waters in front of the Playa should be undertaken prior to detailed design. A small area along the southwest shore of the Bay is also suggested for consideration. Detailed information as well as potential development areas and suggested probings are indicated in the accompanying map, Plate VII.

E 1665

Plate VII Guánica

Condensed Legend*

On-Shore Features

E 1666

Map Units	General Engineering Characteristics: Excavation	Drainage	Foundation
Rock and Residual Soil			
[illegible] Granite	Variable	Good	Good
[illegible] Limestone	Variable	Good	Good to Fair
[illegible] Harder Limestone	Variable	Good	Good
[illegible] Deep soil	Easy	Good to Fair	Good to Fair
[illegible] Tuff, Shale	Variable	Fair	Fair
[illegible] Sandstone	Rock primarily	Good	Good
[illegible] Alluvial Cone and Fan			
[illegible]	Easy	Good	Poor
[illegible] Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Plain			
[illegible] and well-drained Soils	Easy	Good	Good to Fair
[illegible] over granular soils	Easy	Good	Good
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
[illegible]			
[illegible] Sand	Easy	Good	Good
[illegible] Sand	Easy	Good	Good
[illegible] over Sand	Easy	Good	Good to Fair
Tidal Area			
Va Low land	Easy to Medium	Fair to Poor	Poor
Vb Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
x General Location for Limited Probing Program

1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

7. Boquerón

E 1667

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:10,000 hydrographic chart; field reconnaissance.

The on-shore area consists of limestone, tuffaceous rock and sandstone hills, low flood plains, and a coastal belt of beach sands.

Off-shore, a considerable portion of the harbor is filled with deep deposits of fine-textured sediments. There are scattered rock areas in the harbor along the shoreline. At the harbor mouth, there is a major rocky barrier with a narrow channel; area of relatively deep water is located on both sides of the barrier.

In summary, the overall condition of the on-shore and off-shore features of this site is not favorable. Generally, where the water is deep, the land is either limited by topography or of poor soil; where the land area is favorable, the water is shallow and the harbor is filled with mud, requiring extensive dredging. If for some reason that this site has to be developed, consideration may be given to the south side of the outer bay area and further investigations has to be undertaken. Detailed information is indicated in the accompanying map, Plate VIII.

E 1668

Plate VIII Boquerón

Condensed Legend

On-Shore Features

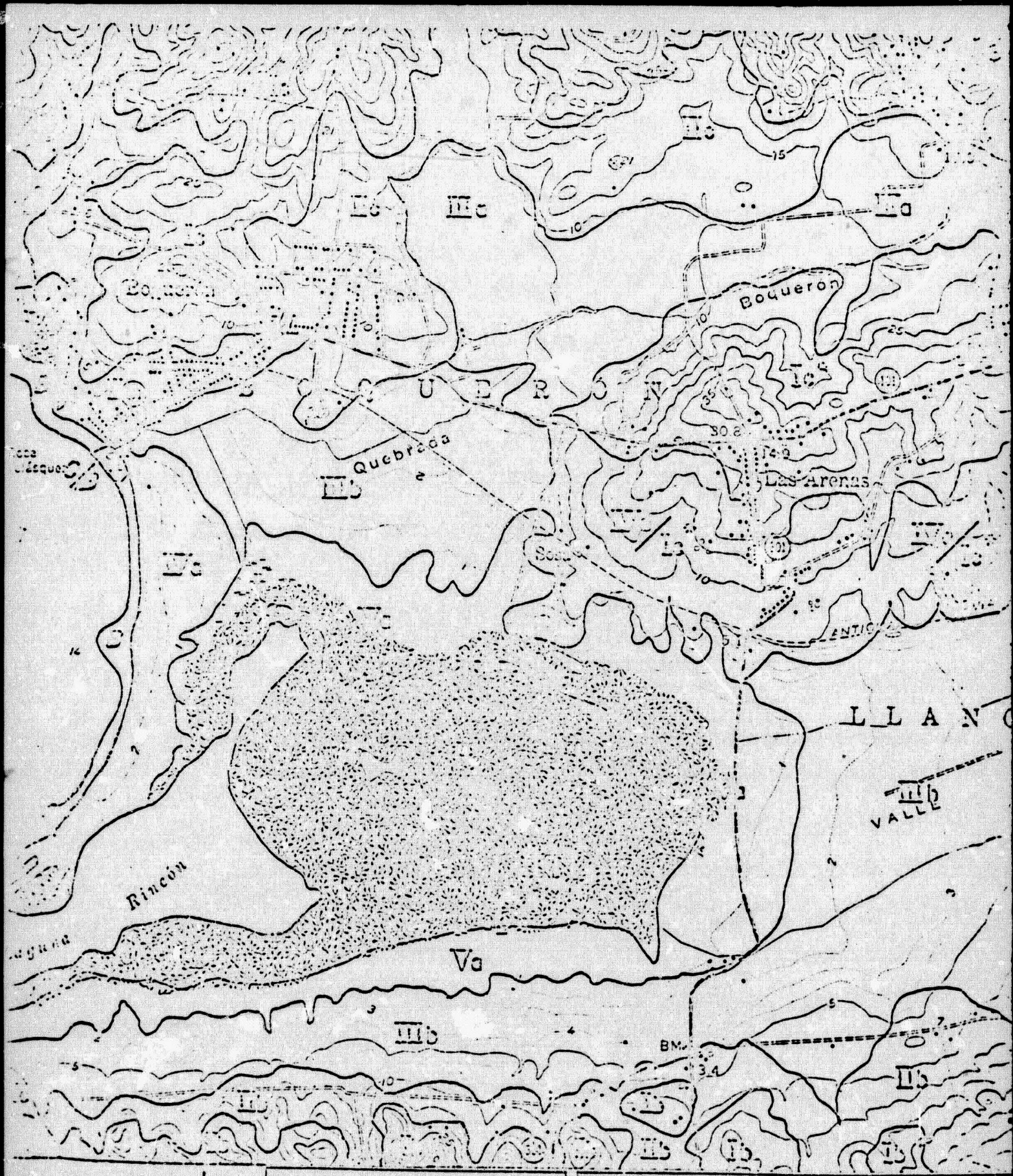
E 1669

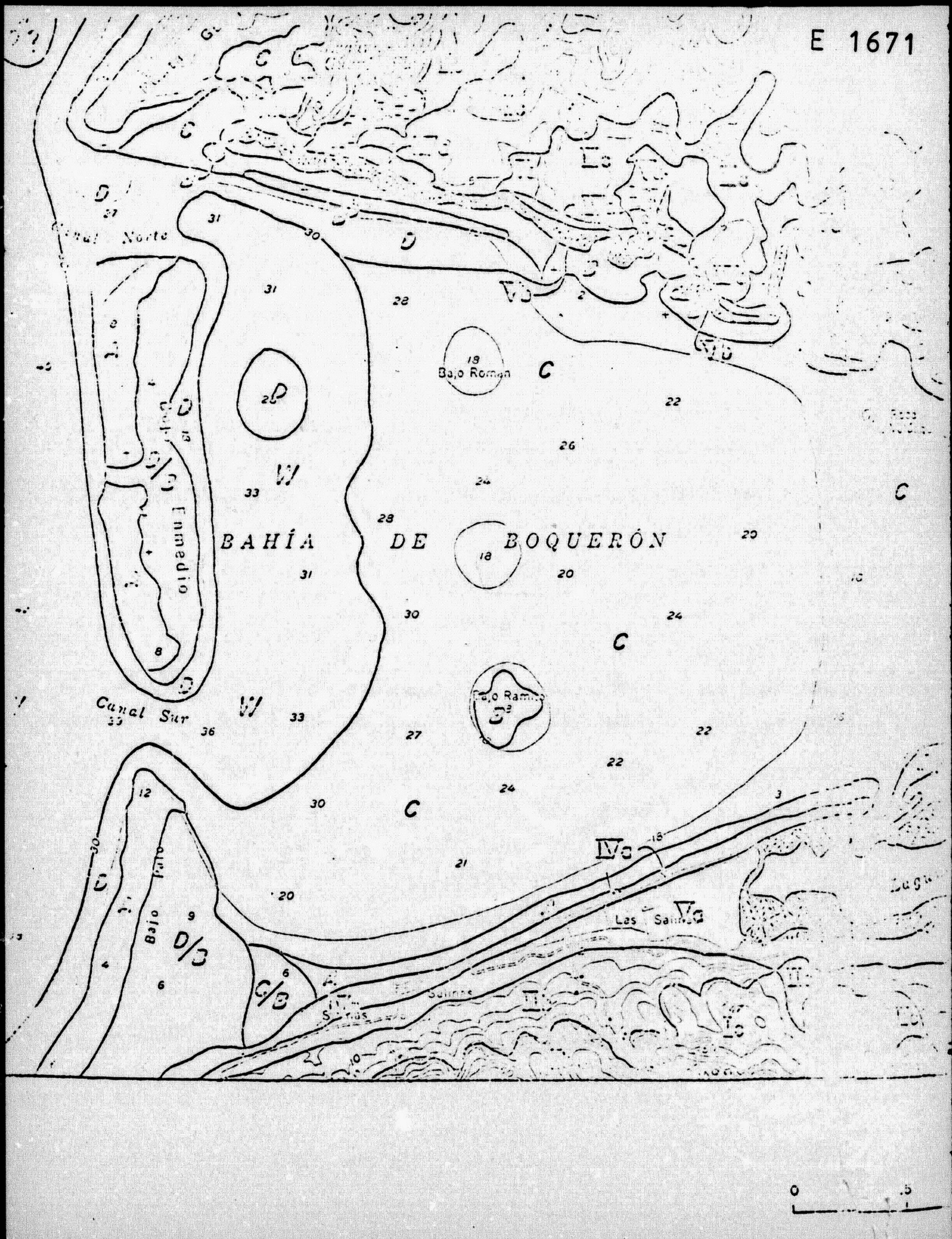
Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
[illegible] and Residual Soil			
Granite	Variable	Good	Good
Limestone	Variable	Good	Good to Fair
Tuff, Shale	Variable	Fair	Fair
[illegible] silt and clay	Easy to Medium	Poor to Fair	Poor to Fair
Sandstone	Rock primarily	Good	Good
[illegible], Alluvial Cone and Fan			
Talus	Easy	Good	Poor
Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Plain			
Silts and well-drained Soils	Easy	Good	Good to Fair
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
[illegible]			
Beach Sand	Easy	Good	Good
Dune Sand	Easy	Good	Good
River Sand	Easy	Good	Good to Fair
[illegible] Area			
Low land	Easy to Medium	Fair to Poor	Poor
Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.


Boquerón
Quebrada
Las Arenas
Rincón
VALLE
Va
IIIb
IIb
IIIc
IIIa
IIIe
IIIb
IIb
IIb
I


E 1671
Canal Norte
Canal Sur
BAHÍA DE BOQUERÓN
Bajo Roman
Bajo Ramos
Bajo Farito
Las Salinas
Salinas
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1

E 1672

8. Puerto Real

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:20,000 scale hydrographic chart; field reconnaissance.

The on-shore area consists of tuffaceous rock and limestone hills, low flood plains and swamps. There is a narrow band of sand at scattered coastal areas.

Off-shore, the water in the harbor is very shallow and filled with fine-textured sediments. There is a rocky barrier at the entrance of the bay and an extensive coral reef growth along the exterior coast.

In summary, the overall condition of this site is not favorable because of the shallow water and poor material in the harbor, the rock barrier, and the limited land possibilities. Detailed information is given in the accompanying map, Plate IX.

E 1673

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Plate IX Puerto Real

Condensed Legen

On-Shore Features

E 1674

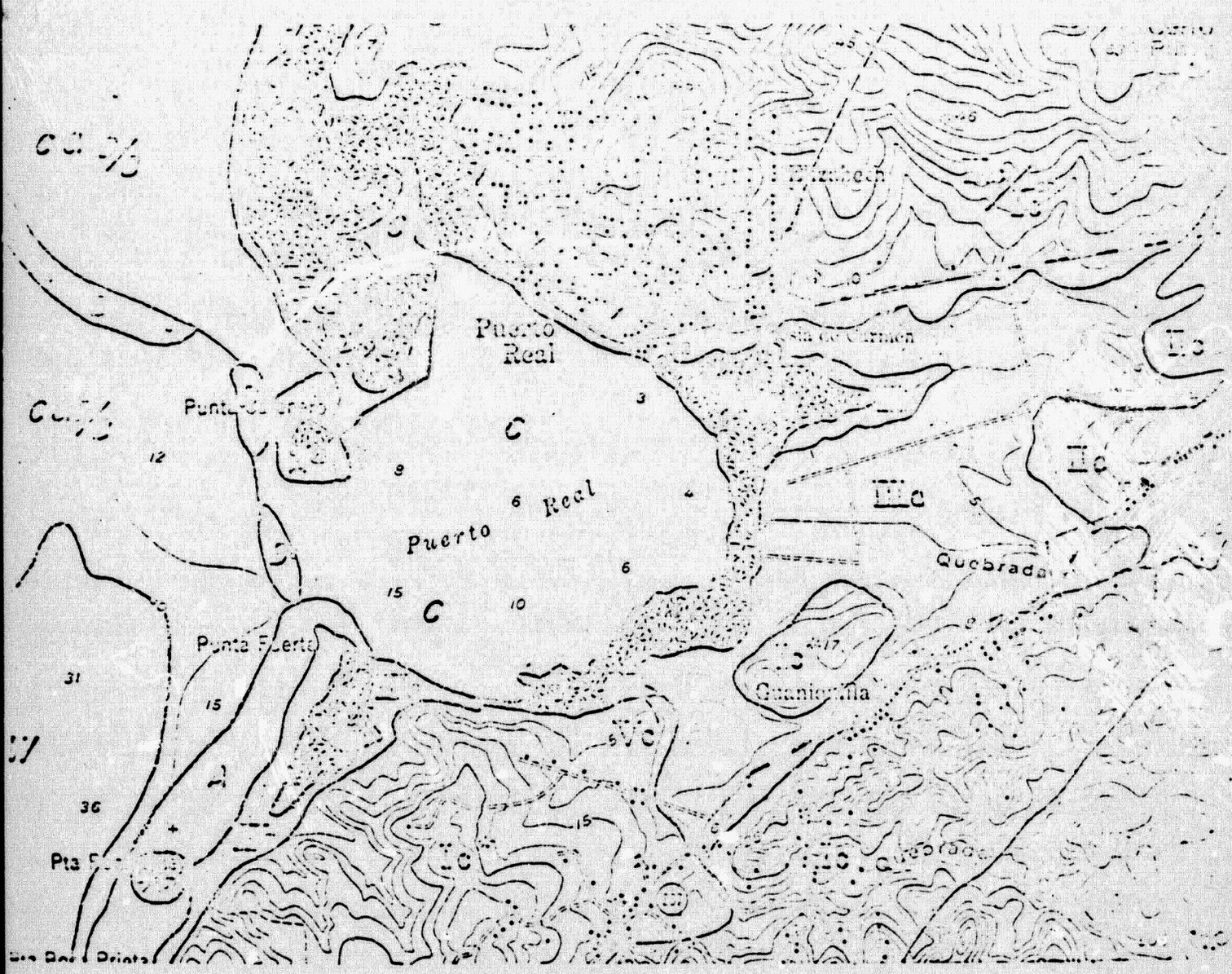
Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
Granite	Variable	Good	Good
Limestone	Variable	Good	Good to Fair
Talc Beds	Variable	Fair	Fair
Ia, Deep silt and clay	Easy to Medium	Poor to Fair	Poor to Fair
Sandstone	Rock primarily	Good	Good
Ia, Alluvial Cone and Fan			
Talus	Easy	Good	Poor
Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Plain			
Silts and well-drained Soils	Easy	Good	Good to Fair
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
Beach Sand	Easy	Good	Good
Dune Sand	Easy	Good	Good
River Sand	Easy	Good	Good to Fair
Coastal Area			
Low land	Easy to Medium	Fair to Poor	Poor
Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

E 1675


Puerto
Real
Puerto
Real
Punta Puerto
Punta Puerto
Quebrada
Quebrada
Guanicilla
IIIc
IIc
IIc
IVc
C
C
C

9. Mayagüez E 1676

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale and 1:4,000 scale airphotos, 1:15,000 scale hydrographic chart; field reconnaissance, and communications from Gahagan Overseas Dredging Company.

The on-shore area consists of hills of volcanic materials, somewhat metamorphosed, and a narrow coastal strip of flat land. The flat land soils are generally satisfactory although the areal extent is rather small.

Off-shore, the sea bottom provides one of the best sources of sand and gravel in the island. Locally there are some rocks buried at various depths. The depth to rock in the dredged area currently being dredged (for instance, the Star-Kist site) is in the order of about sixty-five feet. The dredged sand and gravel has been used most satisfactorily for fills at industrial sites. Off-shore protection from waves is generally favorable and there is no difficulty in navigation.

In summary, the overall condition of the physical features of this site is favorable, the major drawback being that the on-shore land development would be limited by topography. Detailed information as well as potential development area and suggested probings are indicated in the accompanying map, Plate X.

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E 1677

Plate X Mayagüez

Condensed Legend

Ca-Shore Features

E 1678

Map Units	Excavation	Drainage	Foundation
Rock and Residual Soil			
Granite	Variable	Good	Good
Limestone	Variable	Good	Good to Fair
Tuff, Shale	Variable	Fair	Fair
Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
Talus	Easy	Good	Poor
Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
Silts and well-drained Soils	Easy	Good	Good to Fair
Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Sand			
Beach Sand	Easy	Good	Good
Ridge Sand	Easy	Good	Good
River Sand	Easy	Good	Good to Fair
Tidal Area			
Low land	Easy to Medium	Fair to Poor	Poor
Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

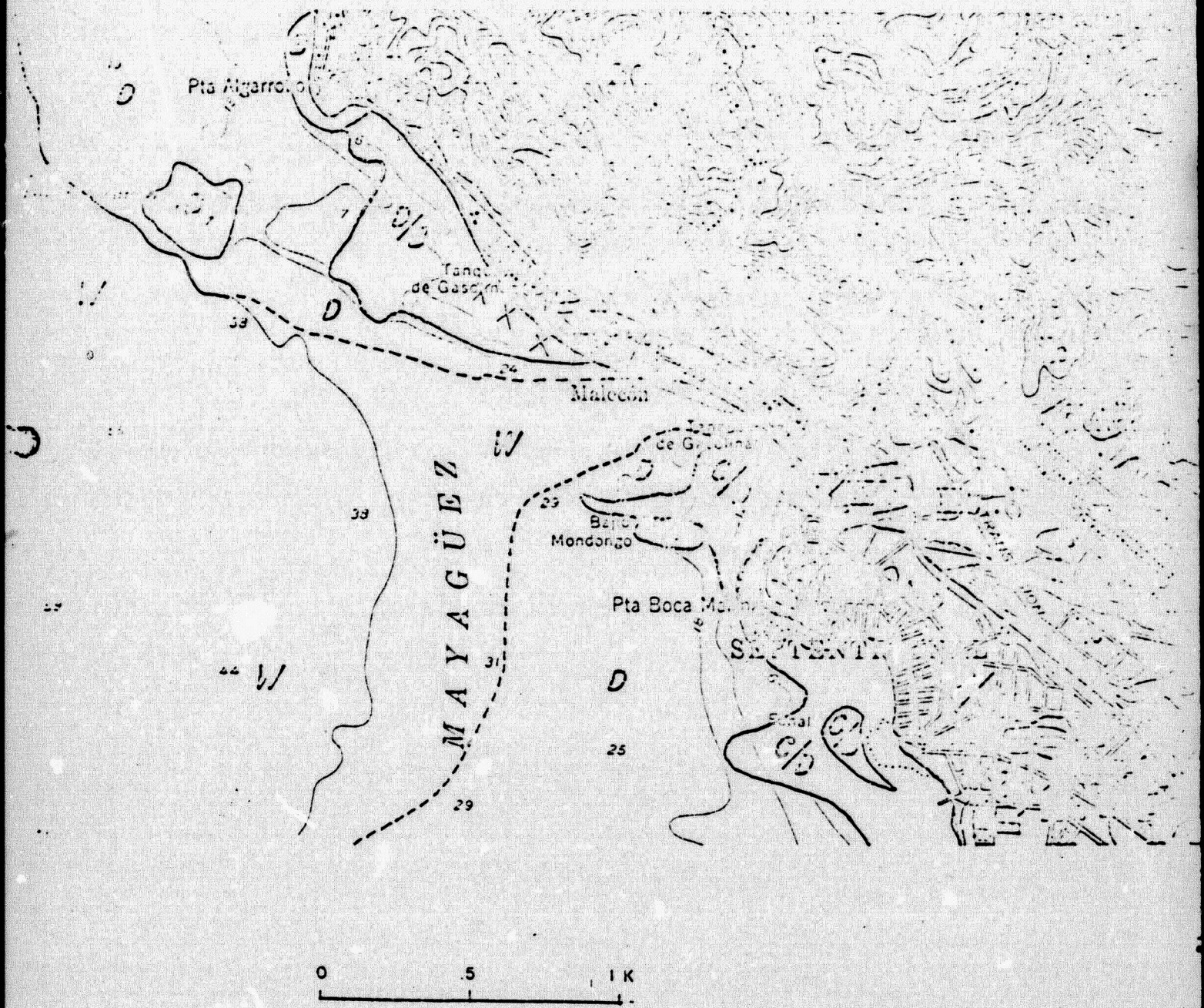
A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
X General Location for Limited Probing Program

1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

E 1679



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S. MAYAGÜEZ

10. Minase

E 1680

Sources of Information: Topographic map, agricultural soil map, geologic map, 1:15,000 scale airphotos, 1:20,000 scale hydrographic chart; field reconnaissance.

The on-shore area consists of hills of volcanic materials and sediments, partly metamorphosed, in the north, and flat areas of flood plains and beach sands in the south. The soil is generally well-drained and favorable for engineering development.

Off-shore, the harbor material is generally sandy with scattered rocks along the north coast; there is sand and some mud along the southern portion of the coast, with sand predominating. The approach to sea is convenient and dredging would be easy and not excessive.

In summary, the overall condition of this site is favorable, considering both on-shore and off-shore features. The land development along the north coast would be limited by topographic conditions, but there is ample space of favorable land at the southern section. Detailed information as well as potential development area and suggested probings are indicated in the accompanying map, Plate XI.

E 1681

Plate XI Alfasco

Condensed Log [illegible]

On-Shore Features

E 1682

Map Units	General Engineering Characteristics		
	Excavation	Drainage	Foundation
Rock and Residual Soil			
[illegible] Granite	Variable	Good	Good
[illegible] Limestone	Variable	Good	Good to Fair
[illegible] Tuff, Shale	Variable	Fair	Fair
[illegible] Sandstone	Rock prim[illegible]	Good	Good
Talus, Alluvial Cone and Fan			
[illegible] Talus	Easy	Good	Poor
[illegible] Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
[illegible] Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Flood Plain			
[illegible] Silts and well-drained Soils	Easy	Good	Good to Fair
[illegible] IIIa over granular soils	Easy	Good	Good
[illegible] Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
[illegible]			
[illegible] Beach Sand	Easy	Good	Good
[illegible] Dune Sand	Easy	Good	Good
[illegible] River Sand	Easy	Good	Good to Fair
[illegible]			
[illegible] Low land	Easy to Medium	Fair to Poor	Poor
[illegible] Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Recommendations

P Potential Area for Port Development
x General Location for Limited Probing Program

Notes:
1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

11. Arecibo

E 1683

Sources of Information: Topographic map, agricultural soil map, geological map, 1:15,000 scale and 1:4,800 scale airphotos, 1:20,000 hydrographic chart; field investigation, and communications from Mr. A. Dauway, Puerto Rico Ports Authority.

The on-shore area consists of sedimentary rock hills, flood plains, beach sands and some swamps. There is also some land filled with dredged material. The on-shore soil condition is generally satisfactory for engineering purpose, although the areal extent of land is relatively limited.

Off-shore, the harbor bottom material is primarily sandy; rocks are found at shallow depths in scattered locations, particularly when close to the rock headland. A relatively small part of the harbor has been dredged to a depth of twenty-five feet. This small area is now protected by breakwater and is suitable for small crafts. The remaining major portion of the harbor, southwest of the dredged area, is composed of deep sand. The wave action there is exceedingly strong; some substantial protective structure would be required for the development of this area.

In summary, the overall condition of this area is not favorable because of the strong wave action affecting the major portion of the harbor. The already developed area is satisfactorily protected by the breakwater, but there, both on-shore and off-shore spaces are limited. Detailed information is indicated in the accompanying map, Plate XII.

E 1684

Plate XII Arecibo

Condensed Legend

On-Shore Features

E 1685

Map Units	General Engineering Characteristics: Excavation	Drainage	Foundation
Rock and Residual Soil			
Ia Granite	Variable	Good	Good
Ib Limestone	Variable	Good	Good to Fair
Ic Tuff, Shale	Variable	Fair	Fair
Id Sandstone	Rock primarily	Good	Good
Talus, Alluvial Cone and Fan			
Ia Talus	Easy	Good	Poor
Ia Alluvial Soils (related to Ia)	Medium to Easy	Fair to Good	Fair to Good
Ib Alluvial Soils (related to Ib)	Medium to Easy	Fair to Good	Fair to Good
Ic Alluvial Soils (related to Ic)	Medium to Easy	Fair to Good	Fair to Good
Coastal Plain			
Ca Silts and well-drained Soils	Easy	Good	Good to Fair
Cb Clays and poorly-drained Soils	Easy to Medium	Poor	Poor
Dunes			
Dw Beach Sand	Easy	Good	Good
Dr Ridge Sand	Easy	Good	Good
De Dune Sand	Easy	Good	Good to Fair
Tidal Area			
Tl Low Land	Easy to Medium	Fair to Poor	Poor
Th Swamp	Medium to Difficult	Poor	Very Poor

Off-Shore Features

A Coral
B Coral or Rock
C Silts and Clays primarily
D Sands primarily
W Water depth greater than thirty feet

Note: 1. For a more detailed description see Part I of this report.
2. Compound symbols: A/B indicates A overlying B at relatively shallow depth.

W* Water depth twenty-five feet; dredged area

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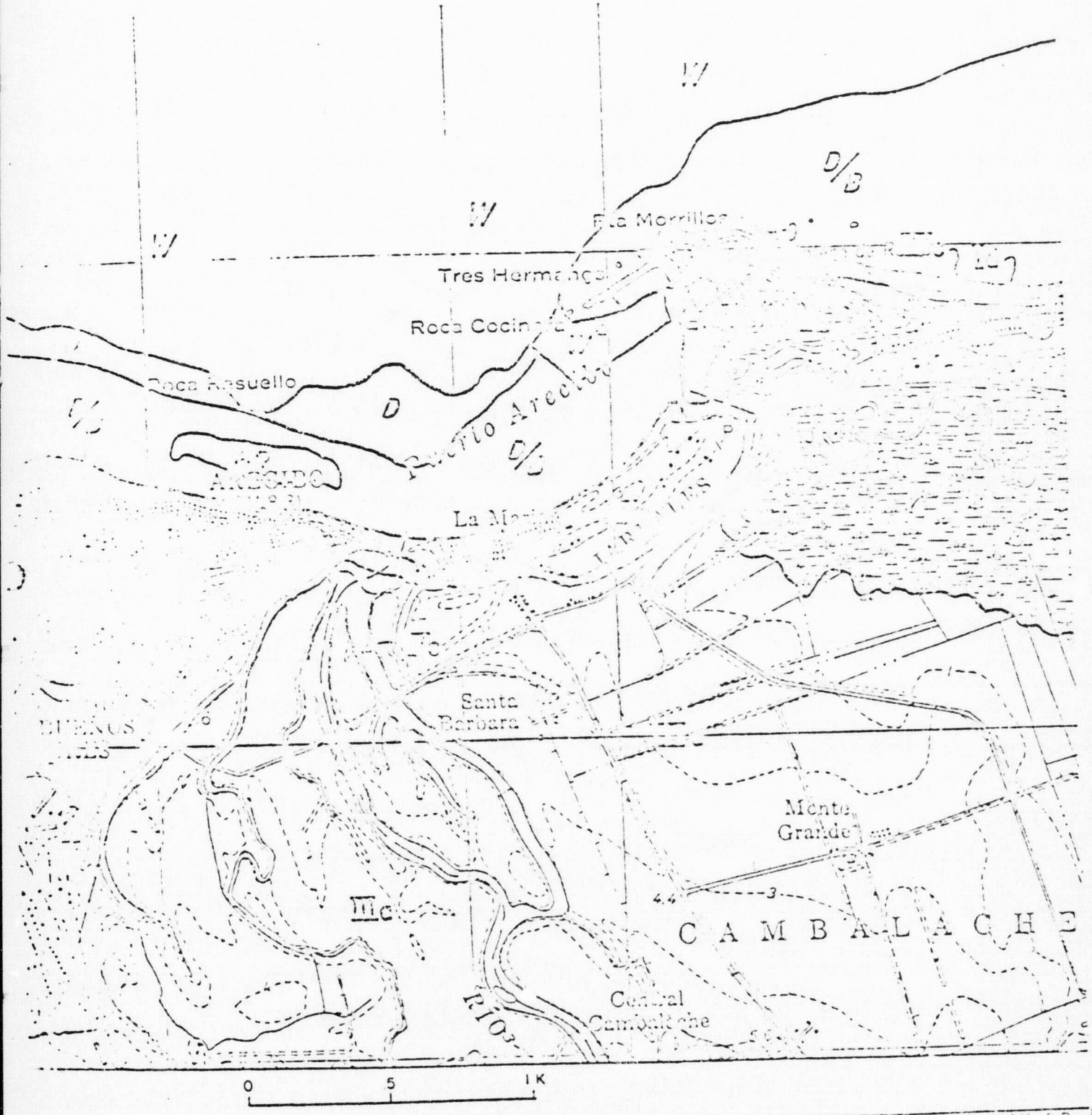

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II. ARECIBO

P-230, Annual Reports of Phillips Puerto Rico Core, Inc., 1967 through 1972

OVERSIZE FOLDOUT(S) FOUND HERE IN THE PRINTED EDITION OF THIS VOLUME ARE FOUND FOLLOWING THE LAST PAGE OF TEXT IN THIS MICROFICHE EDITION.

SEE FOLDOUT NO 2-13

D- 8,"Puerto Rico's Industrial Future"
February 2, 1957

Attachment C

E 1699

PUERTO RICO'S INDUSTRIAL FUTURE

A paper by M. C. Barton, Jr.,
Director of the
Office of Economic Research,
Economic Development Administration,
presented at the
Sixth Annual Meeting of the
Puerto Rico Economics Association,
February 2, 1957,
San Juan, Puerto Rico.

Discussants:

Teodoro Moscoso, Administrator
Economic Development Administration

Bernard Rashkin, General Manager
Pan American Crafts, Inc.

Enrique A. Castillo, President
Puerto Rico Manufacturers Association

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PUERTO RICO'S INDUSTRIAL FUTURE

I think it is a healthy sign, both for Puerto Rico and our profession, that the Economics Association has devoted this series of meetings to a look into the future. The key word in this year's program is "innovations." In this session we will try to see what changes seem to be in store for the industrial sector of the economy.

In economics, I believe one is struck less often by change than by how much things remain the same. Let me illustrate by reading a few key words from the table of contents of the 10-year industrial plan for Puerto Rico which was made in 1950 by Jerry Tallman and others from Arthur D. Little—"Buildings" ("standard" and "special"); "Loans for Equipment and Working Capital"; "Government Purchase of Minority Stock Equities"; "Subsidies" for "worker training"; "shipment of industrial equipment", and "core industries"; and last, but obviously not least, "Tax Exemption". Every word has a familiar ring; in all major respects the plan made 7 years ago is still in operation today.

The essence of this industrial plan was the attraction of Mainland industry with tax exemption as the main lure and with the provision of buildings, financing, and other forms of assistance to help compensate for Puerto Rico's "natural" disadvantages as a location for manufacturing industries. You are all generally familiar with the results. Since 1950, the number of Fomento

plants in operation has increased from slightly under 100 (96) to about 450; the net income produced has risen from 8 to 74 million dollars; and factory employment has increased from 7 to about 35 thousand workers. In these terms the plan has worked—perhaps better than we had a right to expect.

But most of this new manufacturing activity has been concentrated in 4 industry groups: textiles, apparel, electronics, and plastics. All of these "new" industries rely almost exclusively on imported raw materials, and nearly all of them sell the bulk of their output in the U.S. market. Most of the new plants were started by firms whose main base of operation is in the States and their operations are integrated into the U.S. industrial structure, rather than into the Puerto Rican economy. Practically none of the new industries (except canneries) has been established on the basis of local raw materials and, with a few exceptions, the plants started by Puerto Rican businessmen have been small ones, producing exclusively for the local market.

Not long ago I was asked, not by a businessman or professional economist but by a New York City high school teacher whether, in view of this situation, Puerto Rico's recent industrial expansion, which is admittedly rapid and dramatic, was not in reality built upon sand. The question was a good one. If it were not for our close political and institutional ties with the United States, such a development—if possible at all—would rest on a shaky foundation

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indeed. It could be cut off tomorrow if a full set of trade barriers were erected sides of the fence. Because of our economic integration with the States, however, this "new" industry is as securely based as if it were located on the Mainland—except of course for the possibility of a major shift in labor, transportation, or other costs which was uniquely unfavorable to Puerto Rico.

It is important to recognize that there is no more institutional reason for Puerto Rico to have an internally-integrated industrial structure than there is for mining Nevada and manufacturing Rhode Island to each strive for separate, independent economies. There is, however, an economic reason—the added cost to Puerto Rico of shuttling materials and products back and forth to the States. Costs are reduced whenever a Puerto Rican industry can include another stage of processing and export only the lightest and most valuable of finished products.

Similarly, there is no compelling institutional reason for the "new" industries to be locally owned. Most of our large sugar mills were once U.S. or foreign owned, but today, I believe Puerto Ricans have a complete or controlling interest in all but four of them. Conversely, a considerable number of Puerto Ricans have long held stock in the General Electric Company which had 125 or more plants scattered among various states before its first plant was established in Puerto Rico. It is desirable, however, both from

the standpoint of economic stability and the avoidance of undue concentrations of economic power, to foster the entrepreneurial activity of Puerto Ricans in the local manufacturing field. It is interesting to note that the 1950 development plan, from which I just read, stressed the importance both of industrial integration and of fostering efforts by local businessmen to undertake manufacturing ventures. In these two respects, however, our development program has been lagging.

Nonetheless, reading the tea leaves to be found in the industrial situation today, it is my judgment that the most significant innovations and changes during the next decade will be in precisely these characteristics—in the structure and in the ownership of Puerto Rican industry. This is not to deny that we will have many other changes in production and marketing technology by 1965, including more automation. But here, I believe, we will be mainly following the pattern of U.S. industrial development.

With regard to industrial structure, my guess is that the next decade will see a remarkable increase in internal industrial integration. This, I believe will stem, not only from the development of entirely new industrial complexes, but also from further linkages within the existing structure of industry and between industry and agriculture. With regard to ownership, I believe that, with the help of new marketing, design, and investment institutions, there will be a sharp increase in the number of major

HEAVY INDUSTRY POSSIBILITIES, 1965

	NET INCOME ($ millions)	CAPITAL ($ millions)	EMPLOYMENT (thousands)	PAYROLL ($ millions)
6 large refineries	144	600	6	24
6 directly related petrochemical or power plants	144	600	6	24
3 related fibre or plastic plants	32	100	3	12
20 other "basic" establishments*	40	100	5	20
	360	1,400	20	80

* in such industries as heavy chemicals, heavy metals, paper and pulp, textiles, shipyards, glass fibre, meat packing, grain milling, etc.

E 1704

joint ventures and of other substantial undertakings solely by Puerto Ricans to manufacture for export. We all realize that our industry must grow much more and much faster in the future than in the past. It is my belief that this new "new" industry will be highly integrated and more largely locally-owned.

At this point I would like to refer to a set of charts which will now be distributed.

The first table is entitled "Heavy Industry Possibilities—1965." Most of what I am going to say depends on the general validity of this table. I want to define as clearly as I can the basis for these estimates so that you can judge for yourselves the degree of reality they represent. The key estimate is in the first line—"6 large refineries."

As you know, we now have two refineries in operation. Caribbean, located in Cataño, was the first to be established. It is comparatively small and what enabled its establishment was contracts for the sale of both fuel oil and gasoline in the local market. Caribbean already has plans for expansion but its ultimate size will probably be limited to growth in local sales, since the nature of the operation makes substantial exports uneconomical. In other words, there is nothing in the present nature of this refinery operation that would lead one to believe that any substantial expansion of oil refining was economically feasible for Puerto Rico.

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The other refinery now in operation, Commonwealth, which is located in Guayanilla, is quite different. While the pitch, which is the final residue of the refining operation, will be sold to the new electric plant of the Water Resources Authority being built nearby, most of the oil and gasoline, including fuel oil, is expected to be exported. Moreover, this refinery is now being expanded to a production capacity of 55,000 barrels a day, about four times the present capacity of our other refinery, Caribbean. The main reason for this expansion in Commonwealth is to bring it up to a large enough size so that its output of refinery gases will be large enough for an efficient petrochemical operation. Commonwealth, therefore, is included among the 6 large refineries shown in the table, and the petrochemical operation of Union Carbide, which will use the refinery gases Commonwealth produces, is included among the 6 petrochemical plants included in the line below.

All we know about this first petrochemical operation is that Union Carbide will build a $20 million plant to manufacture ethylene glycol. But we also know that Union Carbide, or other interests, plan an additional investment of something in the neighborhood of $20 million in a plant which will presumably process the ethylene glycol. Among the products that seem most likely for the third plant in this complex are synthetic fibres or plastics.

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This takes us to the third line on the table. In other words, we now have one of the large refineries near completion, one directly related petrochemical plant about to be built, and one related chemical plant definitely being planned. A second petroleum and petrochemical complex of approximately the same size has reached the stage where an option has been taken on the land for its site. A third large complex is being considered. Alex Firfer tells me that the spokesman for this third complex is expected to arrive here shortly "to go deep-sea fishing."

Studies we have made of the production and cost situation of fuels and petrochemicals indicate that this encouraging experience in heavy industry promotion is not accidental. Contrary to surface indications, Puerto Rico has a net advantage, because of tax exemption, as a location for the petroleum industry. Given petroleum refineries, it then has a "natural" advantage for petrochemicals and some kinds of related chemical plants. The origin of our advantage for petroleum refining lies in the present imbalance in demand for petroleum products in the U.S. and in Europe. In the U.S., the demand for fuel oil has been growing comparatively slowly because of increased use of natural gas and coal. Demand for motor fuels, however, has been growing rapidly with the expansion of automobile and air travel. In Europe the situation is reversed. High taxes on motor fuels have held [illegible]mobile travel, while postwar industrial recovery has [illegible] a demand for fuel that is far in excess of Europe's dwindling coal resources.

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It seems that this imbalance may become increasingly great—a stronger and stronger demand for light motor fuels in the U.S. and for diesel and fuel oil in Europe. From a physical standpoint, a balance could be brought about by the establishment of new refineries in Europe selling excess light fuels in the U.S.—or by the establishment of new refineries in the States selling excess fuel oil to Europe. The first alternative, however, is barred by U.S. import duties on gasoline. Thus, it seems likely that any substantial number of the new refineries to be built in the U.S. must market part of their fuel oil output in Europe. New refineries in the States needed to meet gasoline demand will now have an additional freight cost in marketing their fuel oil output. This is an export cost which would have to be in any case, by a new Puerto Rican refinery. In other words, the comparative disadvantage of a Puerto Rican refinery in manufacturing and distribution costs has now been reduced.

According to our calculations, moreover, Puerto Rico now has a net overall cost advantage after tax and financing considerations are taken into account. Property taxes are a major cost in this highly capitalized industry. Moreover, since "independent" refineries are financed to such a great extent with borrowed funds having a fixed rate of interest, variations in corporate income taxes have a violent effect on net profits. According to our preliminary studies, exemption from property and corporate income

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taxes offers the prospect of relatively large capital gains to the promoter and common stock holders of a Puerto Rican refinery. This advantage can be further enhanced if the profit, instead of being realized in the States, is reinvested in new tax-free enterprises in Puerto Rico. Thus, it appears from our preliminary research (this highly technical work has been done mostly by Sam Van Kyning) that some new U.S. refineries must now be planned to export fuel oil and that tax exemption is particularly significant for this heavily capitalized industry. These findings, together with recent promotion experience, lead us to believe that several more oil refineries, probably larger ones than Commonwealth, may soon be established in Puerto Rico.

Returning now to the table and recalling that we already have one quite large refinery being completed, one petrochemical plant and probably a related chemical plant about to be built; that some commitments, though not binding ones, have been made for a second such complex; and that a third refinery is being considered—it seems reasonable to me that we may get as many as 3 refineries and 6 petrochemical plants during the next 9 years. Time is of considerable importance, since there will be a strong incentive for the owners of the first refineries and petrochemical plants to reinvest their early profits in new tax-free enterprises. A word of caution—we have yet to solve the unknown of South Coast industrial water supply for these and other heavy consumers of process water.

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E 1710

The reason for going into this matter of the refineries and petrochemicals at some length is that they provide the basis for an integrated kind of industrial development which we have not yet experienced. Note that petrochemicals can branch out either into synthetic fibres or into plastics. Textiles and apparel, and plastic fabricating are among the largest of our already established industries. So we now have the prospect of having a large segment of our established industries being integrated, backwards, into a local petrochemical base. In fact, there is now under consideration a prospective plant which I have not yet mentioned. This plant (which is now planned to use imported chemicals) is intended to produce synthetic fibres, both for export and for consumption by local textile mills. The resulting textiles would be suitable for a large part of our existing apparel industry. Integration may start from either end--or simultaneously from both ends of the process. While it is unreasonable to expect that there will be full and perfect integration of all the basic, intermediate, and fabricating industries related to petroleum and petrochemicals within a 9-year period, a substantial amount of new, integrated production seems to be already assured.

In addition to this major complex built on a petroleum and petrochemical base, you will note that the fourth line on the table mentions "20 other basic establishments" in such industries as heavy chemicals, heavy metals, paper and pulp, textiles, shipyards,

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glass fibres, meatpacking, grain milling, and the like. Here again there is obviously nothing sacred about the number "20" nor the net income, capital, employment, and payroll figures that follow. We already have, however, one heavy chemical plant under construction, the Gonzalez ammonia plant in Cuánica. The García Commercial interests are building a rolling mill to manufacture concrete reinforcing bars from scrap steel. W. R. Grace & Co., has already purchased and is expanding the Porto Rico Container Corp., and will invest $3 million in a new pulp and paper mill which will use bagasse from Central Cambalache in Arecibo. I mentioned above a new fibre and textile operation now being considered. We believe that others are likely. Our own research has indicated that shipbuilding is a feasible operation in Puerto Rico and we have had a recent inquiry from a major shipbuilder, possibly stimulated by the fact that the Federal Government now provides 100% financing for new merchant vessels. Our feasibility studies have also shown that glass fibre manufacture, based on local sand and limestone, is probably feasible in spite of our relatively high fuel cost, and here again we have a major producer showing active interest. Both meatpacking and grain milling have obvious advantages for the economy and have long been under study. The president of a substantial U.S. grain milling firm will submit a proposal to his board of directors in March. Thus, of the possible "20 other basic establishments" shown on the table, we already have eight being built, definitely being planned, or in likely prospect.

4-13

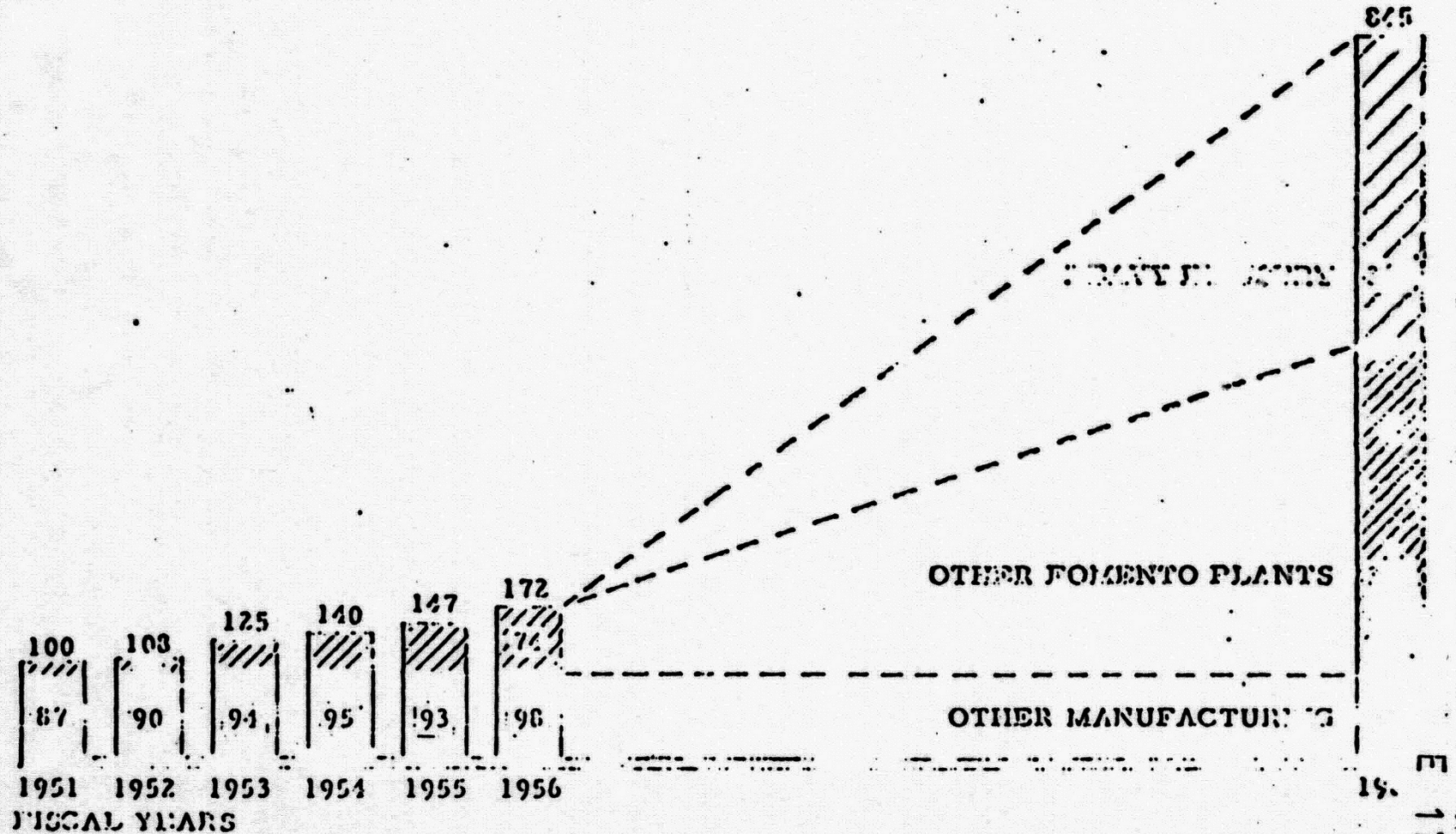
E 1712

All this development of heavy industry has started within the past two years and the bulk of it within the last six months. As a phenomenon it is so new that this table represents a first attempt at making an estimate of the aggregates that may be involved. It is evident from the totals of the 4 columns that these capital intensive industries call for a very large investment. $1,400,000,000 of capital is approximately 6 times the total investment in all Puerto Rican manufacturing establishments at the end of fiscal 1953. Direct employment of 20,000 factory workers is a small number in relation to the amount of capital invested. But it is a large number of jobs and particularly significant because it will be largely male employment, in contrast to the present situation among Fomento plants which employ two-thirds women. What is most important, these basic industries provide a new local source of raw materials for a large number of fabricating industries, and the large return to capital (which is combined with payroll in the net income column) provides a source of funds for future investment in Puerto Rico that is much larger than we have had heretofore. As you realize, the bulk of new investment in the States comes from undistributed corporate profits rather than from individual savings. Industrial integration tends to become automatic when a manufacturing firm invests its own money in a new operation. But in Puerto Rico, corporate savings have not been, up to now, an important source of new industrial investment.

H 14

MANUFACTURING NET INCOME

(In millions of dollars)



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E 1713

E 1714

I should like to turn now to chart #2, which compares the net income from this new heavy industry with our past manufacturing net income and with the projections which Fomento and the Planning Board have been using for 1965. Looking at the past we can see that "other manufacturing," which represents mainly the sugar, tobacco, and apparel industries existing prior to Fomento, has shown comparatively little recent growth. The rise in net income produced by Fomento plants, however, has been quite rapid. By the end of the current fiscal year, net income from Fomento plants will probably be greater than the net income produced by the "old" industries and the spread will become progressively greater as time goes on.

The critical element in this chart lies in the future. The net income of $335 million shown for "other Fomento plants" in 1965 is an estimate made about a year ago by Planning Board and Fomento economists. No one pretends that projections of this sort are, or can be, highly accurate. They are no more than guesses based on past experience and assumptions about future conditions. For example, allowance was made for a recession which has not yet taken place and conceivably, may not occur before 1965. At the moment, therefore, we are about a year ahead of the projection.

In making this projection, comparatively little weight was given to the possibility of rapid development of heavy industry in Puerto Rico. There was no basis for projecting a major growth in

4-16

E 1715

heavy chemicals until the announcement of plans for the expansion of Commonwealth Refinery and for the related petrochemical operations. It was only then that we started the research which subsequently indicated the potential of this industry for Puerto Rico and the probability of its development and proliferation into a basic industrial complex.

The crude projection of total manufacturing net income which you see here (the top dotted l...) merely represents the addition to the old projection for 1965 of the additional amount of net income which now seems possible from heavy industry. Any such growth in heavy industry will probably have a considerable effect on the internal composition of "other Fomento plants" and also, perhaps, on the total amount of net income which they produce. We have already noted the possibility that our textile, apparel and related industries will be greatly strengthened because of the provision of a local materials base. Other labor intensive industries, however, let us take artificial flowers as an extreme example, will be facing increasingly strong competition expressed in the form of higher wages. The refineries today are paying about $1.80 an hour and, for the purposes of these projections, it was assumed that they would be paying $2.00 an hour in 1965. Even though the heavy industries employ mostly male labor, the impact of these rat... on our entire wage structure may be substantial. The strongest effect will probably be on male labor in agriculture,

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construction and industry. This, in turn, will exert some upward pressure on wages for women. It seems to me, therefore, that the tendency will be to slow down somewhat the growth in non-integrated, labor-intensive industries and to speed the expansion of those sectors of existing industry which have been strengthened by the addition of a new, local raw materials base.

Some of these effects may be quite indirect. For example, local production of ammonia for fertilizer should tend to increase fertilization of crops, while higher wages tend to make farm labor more costly. These forces should tend to accelerate mechanization in agriculture and, at the same time, produce a relatively rapid rise in wages for a somewhat reduced number of farm workers. Nevertheless, even though structural changes elsewhere in the economy caused by the addition of a large heavy-industry sector may be considerable, I have assumed for the purpose of this paper that the net income produced by the new heavy-industry sector will be merely superimposed on the total amount of manufacturing net income which we have been projecting, up to now, for 1965.

Similarly, in the next chart on "Manufacturing Employment" I have assumed that the 20,000 workers employed in heavy industry will be a net addition to the number previously projected for manufacturing employment. Twenty thousand is a substantial number, but from the standpoint of employment, the addition of the new heavy industry sector will probably be felt more outside the manufacturing field than within.

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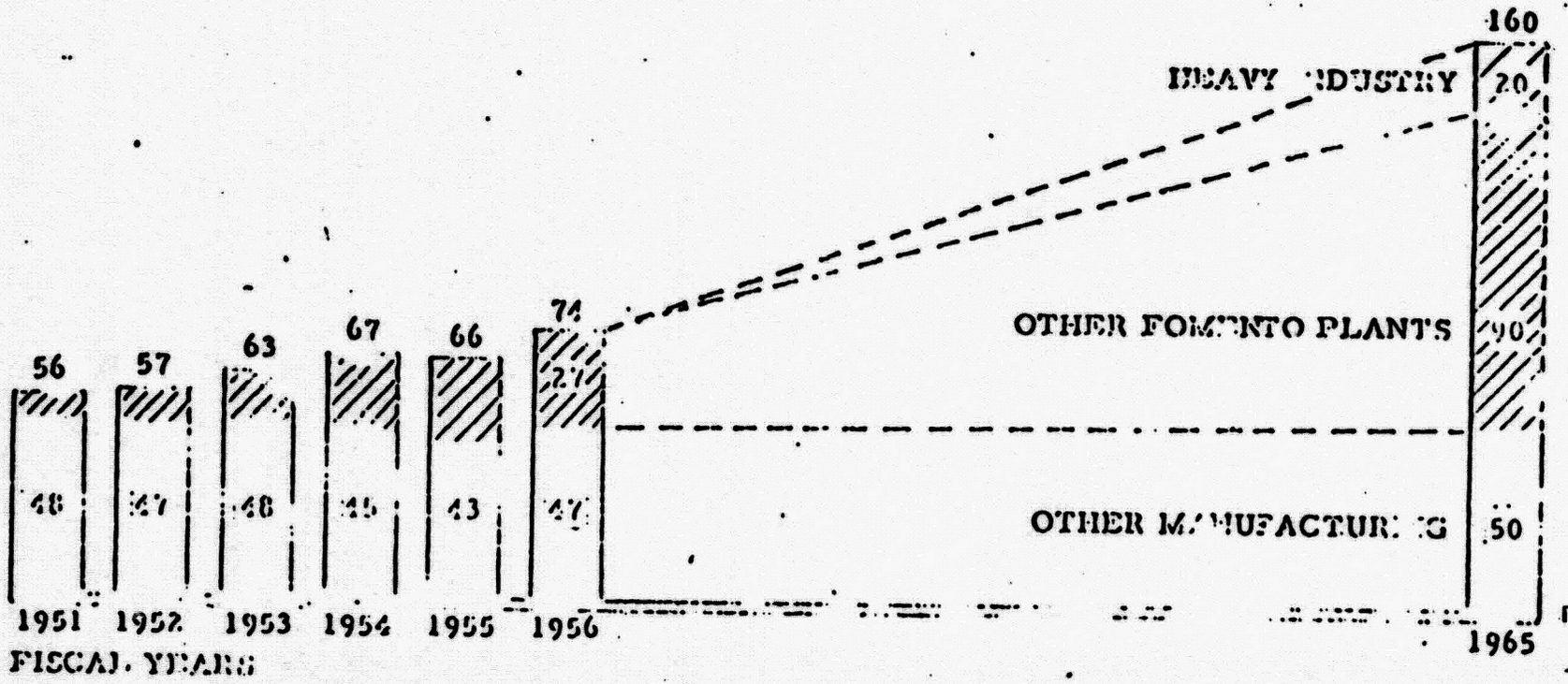
MANUFACTURING EMPLOYMENT

(thousands of workers)



4-79

E 171

You are all familiar wi . the phenomenon partly illustrated in the earlier years of this chart. M nuf sturing employment increased while employment in other lines, notably agriculture and home needlework, declined. This h s made it impossible to relate an increase in primary employment to any corresponding increase in secondary employment. Even though we have been able to measure in a rough way the multiplier effect of industrialization on total income, the employment multiplier would appear on the surface to be negative. Actually it has been expressing itself mainly in the form of higher quality of job , rather than in the creation of new employment opportunities of an unskilled nature. Eventually, however, this dilution of the effect of new manufacturing jobs will diminish as under-employment in the rest of the economy is reduced and, for reasons which will emerge later on, it is possible that the <u>indirect</u> effects of adding a new heavy industry sector to the economy may result in our approaching full employment by 1965.

The next chart on manufact ng investment would appear to show a h ly unrealistic projection if based only on the past statistical record In the last ei years, investm t in manufactu n has approximately doubled. During the next nine years, the rate of increa s shown is no than twice as rapid. But note the column shown for 1953. We had a $43 million investment in heavy industry during the fiscal year but this is too small an amount to provide enough space in the bar to print the number. Today,

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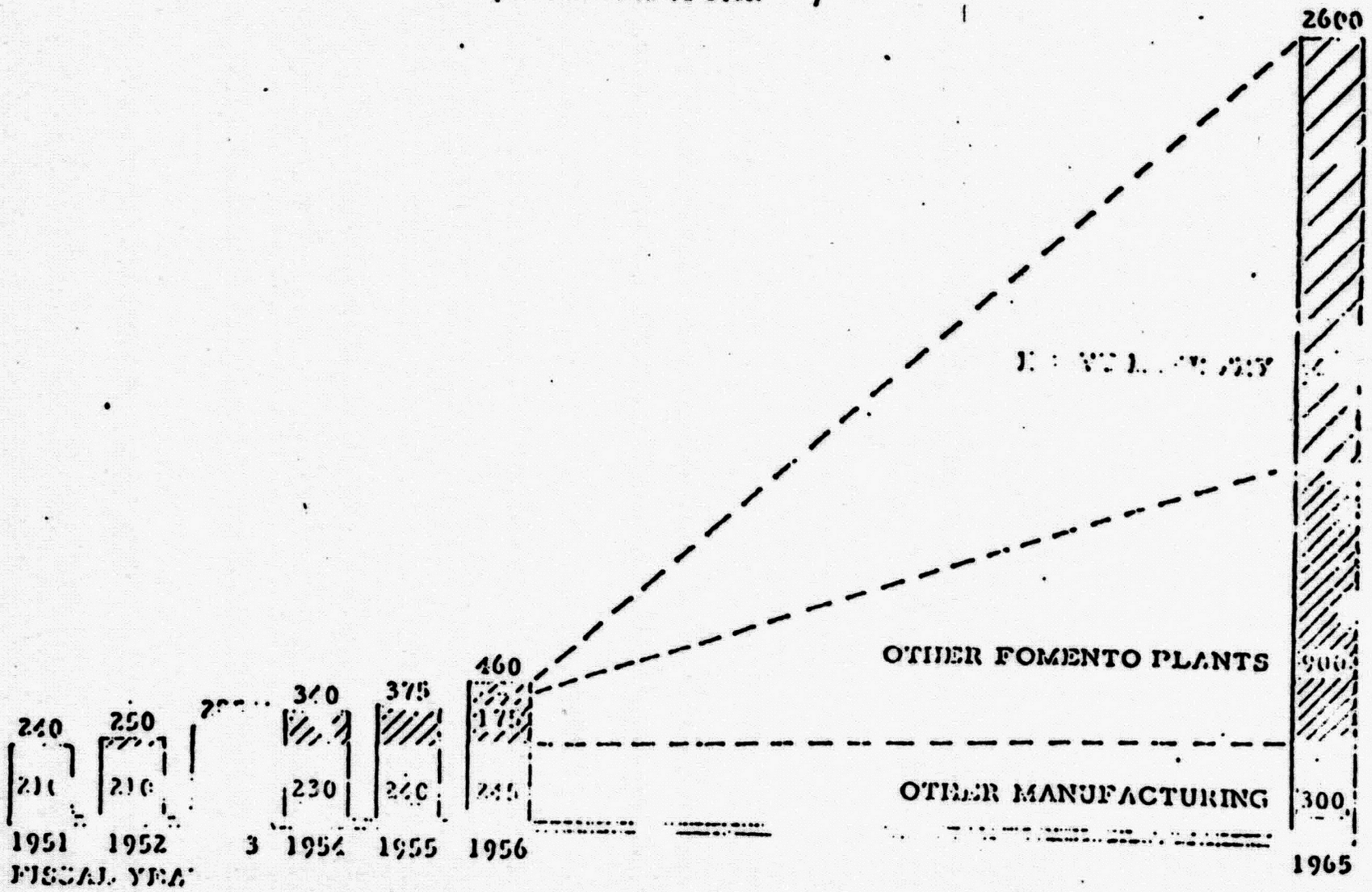
MANUFACTURING INVESTMENT

(in millions of dollars)



E 1716

13-H

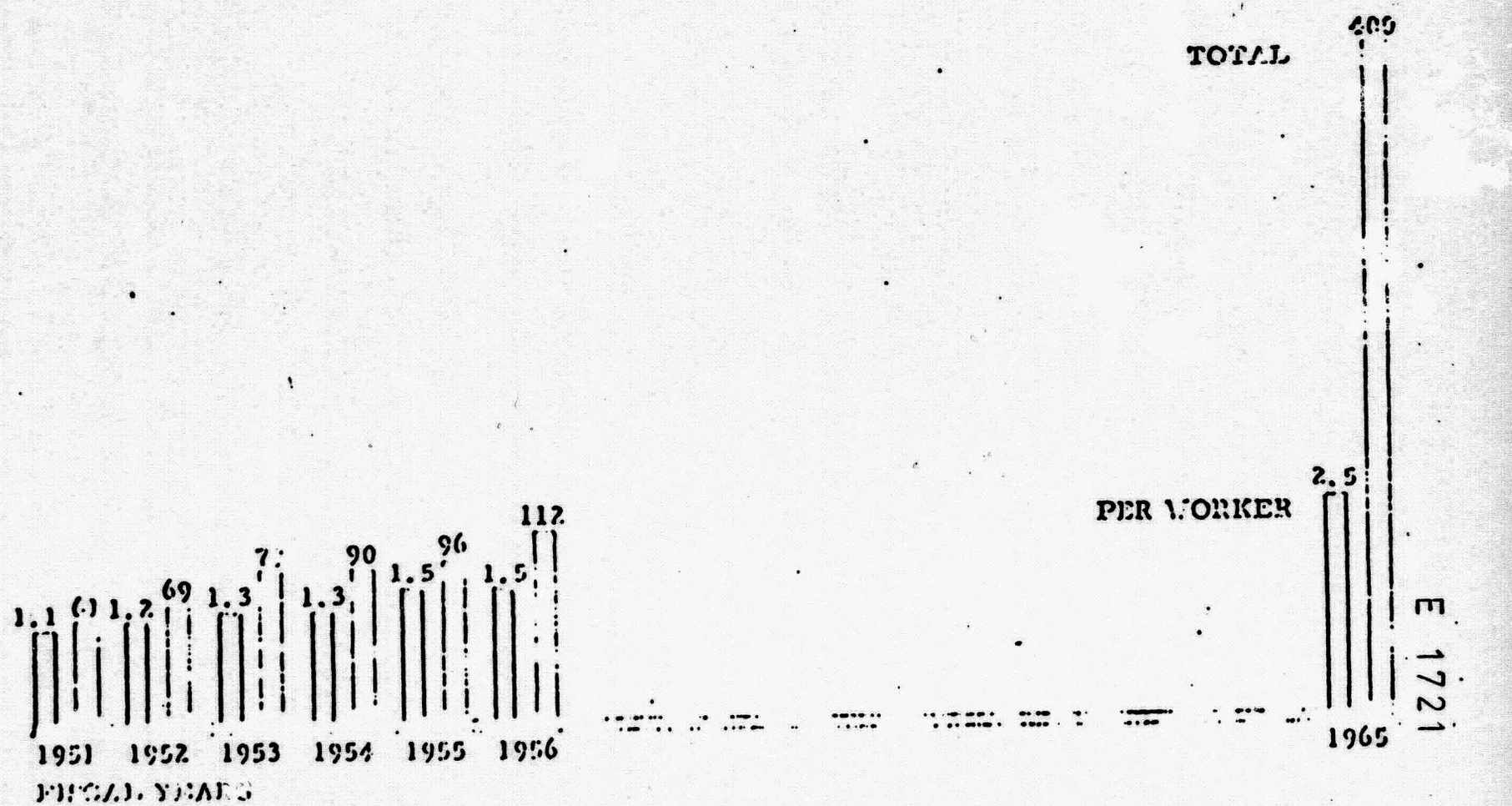
however, an additional $100 million investment in heavy industry is an established fact and projects amounting to another $200 million are being considered. In other words, we may be this morning very close to the steep-trend projected on the chart, which would bring us to a $2,300,000,000 total by 1963.

Most of us are aware that, even today, the Government resources available for investment in industrial development are quite limited. Certainly Government participation must be relatively smaller in the years ahead. Financial assistance, however, is not a significant factor in the promotion of the petroleum and petrochemical industries. The Government asked for, and received, a small interest in Commonwealth Refinery in order to start building a portfolio of securities for use in the future development of financial institutions in Puerto Rico. But the amount of money was small and not essential to the establishment of the plant. Government investment will necessarily be small in the future, as well, and virtually the entire heavy industry increment will probably have to be financed by industrial and institutional investors, mostly from the Mainland. It is expected, however, that Fomento will continue to construct some factory buildings and that the Government Bank will continue to make loans to "other new Fomento plants." Even here, the Government's relative participation must probably be reduced.

H:2

MANUFACTURING PAYROLL

(total, in millions of dollars; per worker, in thousands of dollars)



E 1721

The effect of heavy industry on manufacturing payroll is estimated in the next chart. Income per worker is expected to rise from the current figure of $1,500 to $2,500 a year. Total manufacturing payroll is expected to reach about $400 million, 3 1/2 times its present level. These are significant changes, but I would like to defer appraisal of the overall prospects for employment and incomes until we examine briefly two other aspects of structural change.

The next chart shows estimates of manufacturers sales in the local market and for export. I want to underline the very approximate nature of the historical data shown. Figures for the fiscal years 1951 through 1956 have been estimated mainly on the basis of calendar-year Census data for 1953 and for 1954. For what these estimates are worth, they indicate that most of the increase in local market sales took place between fiscal 1951 and fiscal 1954. In that period the local furniture and beer industries, for example, were expanding rapidly, the latter mainly by displacing imports. Since that time, there has been no further expansion in the "old" industries as a group and all the increase in manufacturers sales has been made by Fomento plants, most of which produce largely for export. On this account, exports rose from 53% of total sales in 1954 to 57% in 1956.

In projecting for the [illegible] it has been made that from now on [illegible] market will be

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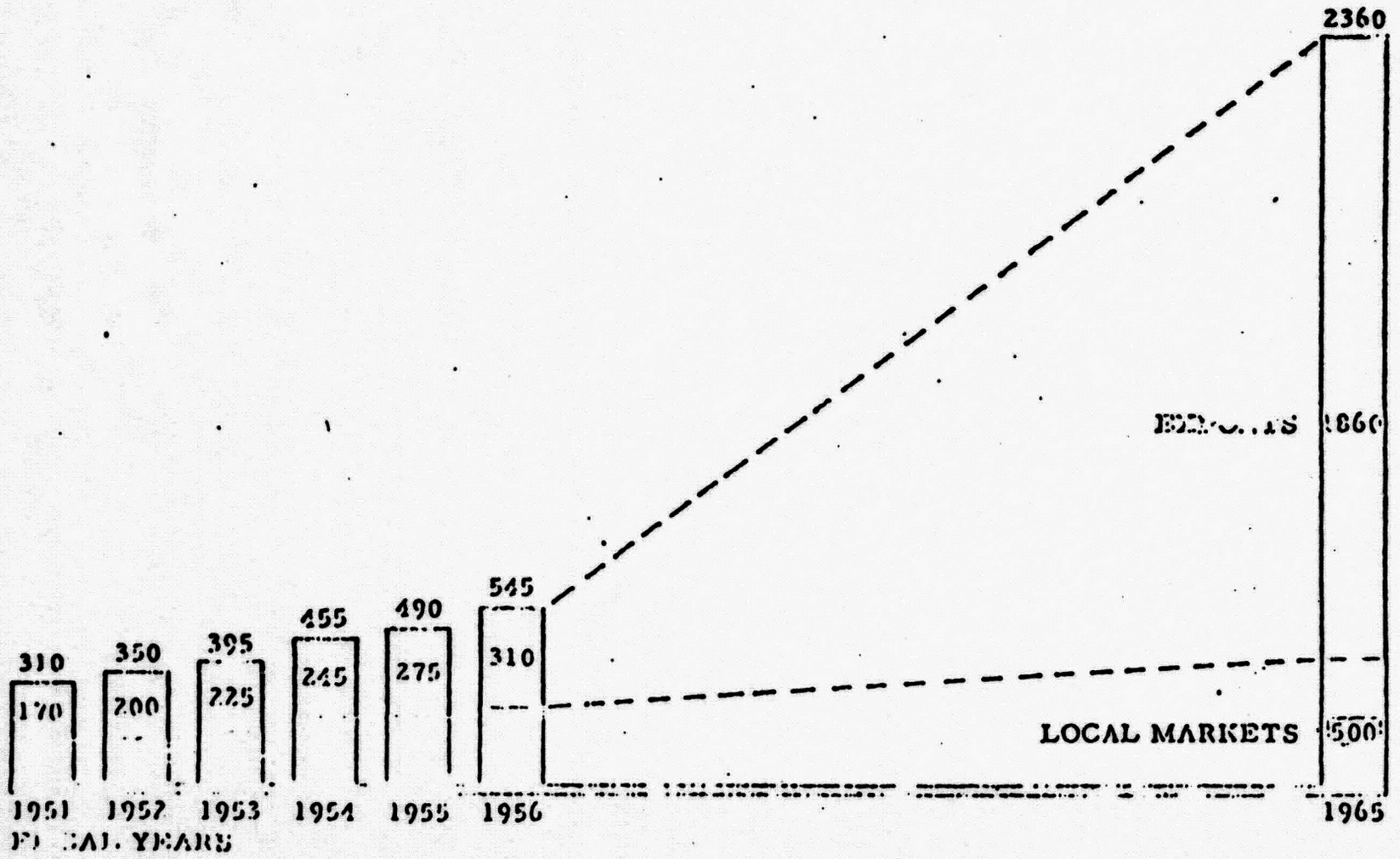
MANUFACTURERS SALES, in millions of dollars

(based on census data for 1952 and 1954; other years approximated)



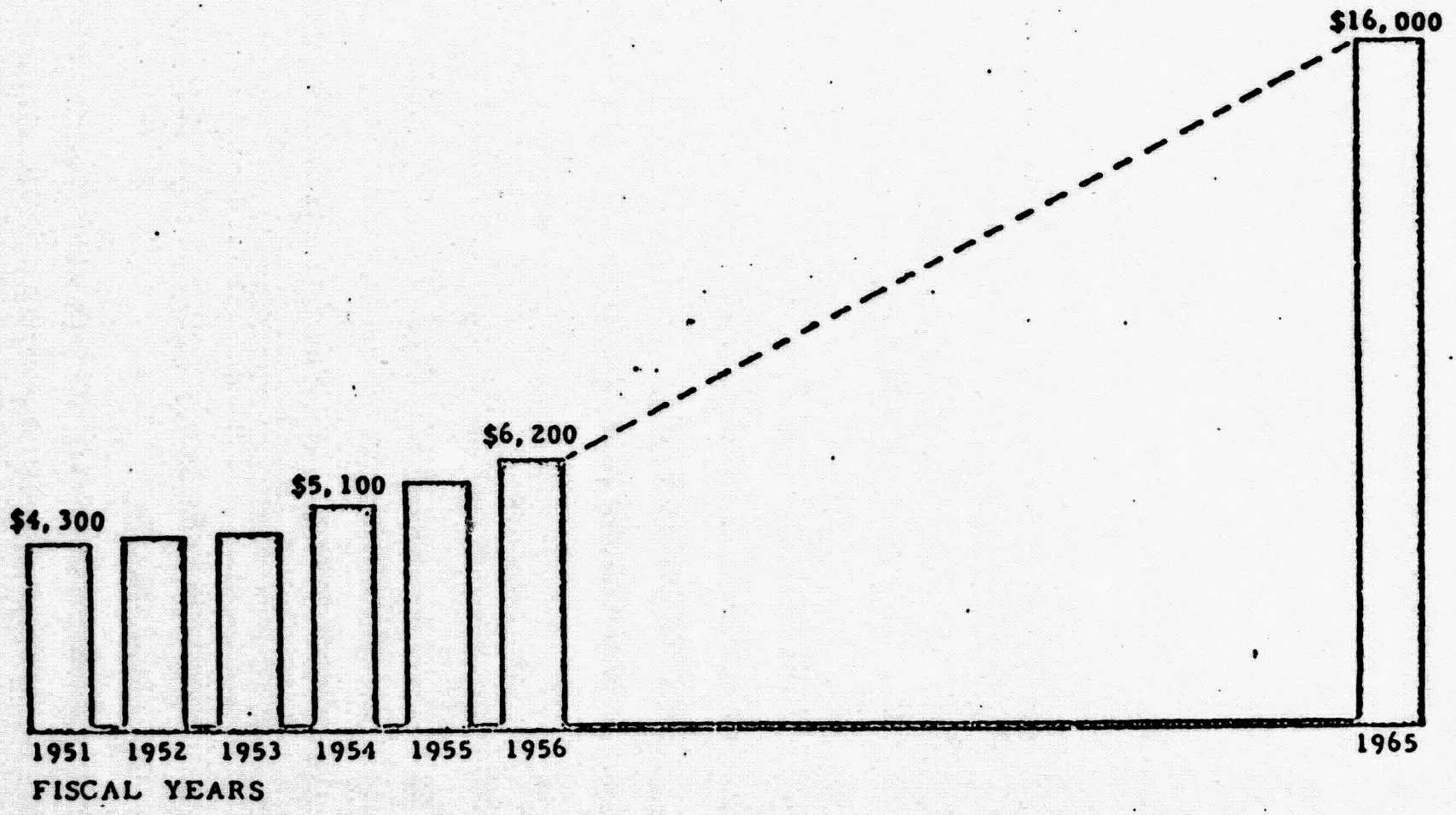
E 1723

limited to the rate of increase in consumer demand. On this basis, it is calculated that sales for local consumption will approximately double during the 9-year period, rising from about $235 million in fiscal 1956 to about $500 million in fiscal 1965. During this same period, however, the projection shows a six-fold increase in exports. By 1965 it is expected that 75% to 80% of total factory output will be for export.

Will Puerto Rican manufacturers be able to enter this rapidly expanding export sector? At the present time there are very few Puerto Rican firms producing for export, outside the agriculturally-based sugar and tobacco industries. Expansion in these two industries continues to be limited by quotas. It is evident that Puerto Rican manufacturers must be able to penetrate Mainland and other external markets if they are to share fully in the manufacturing advance which appears to lie ahead.

The magnitude of one problem facing local manufacturing entrepreneurs is suggested by the capital-per-worker data shown in the final chart which you have before you. During the last three years, investment per worker has been rising rapidly. A very preliminary estimate for fiscal 1957, based mainly on the effect of the construction now going on at Commonwealth Refinery and the González Ammonia plant, raises the figure to approximately $7,000 a worker. At the present time, manufacturing investment per worker in the U.S. averages about $10,000. It is obvious that we are fast

MANUFACTURING CAPITAL PER WORKER



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approaching this figure and, if the estimates made in the first table we discussed and shown here on this chart are at all correct, we will soon have an average investment per worker considerably above the Mainland average.

This may at first glance appear startling but I believe it becomes readily understandable when we realize that this rapid rise is largely the result of adding a new heavy industry sector. Up until now there has been relatively little difference in average investment per worker in Fomento plants and in our "old" industries. Both groups include highly capitalized plants, like sugar in the "old" and cement in the "new," and both groups include plants with a very low investment per worker, particularly in the apparel industries. All the rise in the average shown for 1956 can be accounted for by a $15 million investment in one plant, Caribbean Refinery, in which investment per worker amounts to about $82,000. Investment per worker in the heavy industries shown in the first table averages about $70,000. This is the old story of averaging horses and apples. But the average of $16,000 per worker does mean that we are estimating that petroleum and petrochemicals will be <u>relatively</u> more important in Puerto Rico by 1965 than they are now in the States. Average investment per worker in all other Puerto Rican industries may well continue to be somewhat lower.

It seems indicated, therefore, that Puerto Rican entrepreneurs will have to mobilize more capital and find new export markets in

Finally, just a word about the general economic significance of the industrial possibilities we have been discussing. If we are able to build into our economy a new heavy industry sector of the magnitude I believe possible and if migration, agricultural development, and other economic forces conform to the model that has been projected by the Planning Board, we may reach substantially full employment and be approaching our family income goals by 1965.

Even allowing for greater "leakages," the addition of $360 million in primary manufacturing income should increase previously projected Commonwealth Net Income by roughly $600 million. Total Commonwealth Net Income would then amount to about $2.4 billion dollars, more than double its present level.

In what has gone before, we have been focusing on the manufacturing sector of the economy and have been treating the possibilities for heavy industry as being superimposed on what we had been previously projecting. Clearly, however, injection of a new heavy-industry sector into the economy would have far-reaching effects, not only on manufacturing itself, but throughout the entire economy. It seems obvious, for example, that the 20,000 additional workers employed directly in the heavy industries would represent only a small part of the total employment generated and that there would be a strong upward pressure on productivity and wages in all lines of business.

Hqc

Even with sharply increased productivity, $600 million of additional income should provide good jobs for roughly 200,000 workers who would otherwise be unemployed or underemployed. With total net income in the neighborhood of $2.4 billion, per capita income would probably be over $1,000 and average family income over $5,000—more than double present levels. Under such circumstances, social services financed by progressive taxation should be able to bring substantially all families up to the $2,000 minimum income level which is the basic purpose and goal of our entire economic development effort.

I believe all this is possible. But it is not automatic. Without making a determined effort, we will fall short; without practicing self-restraint in social and individual consumption expenditures, we will lack the financial means; without good luck—but this I don't have to say—I firmly believe that our good luck will continue.

E 1729

order to share fully in the expansion ahead. For this reason, forward planning in Fomento has been concentrated on the establishment of institutional means to assist local businessmen in undertaking manufacture for export. Among the institutions now being planned are a Trade Center to help with merchandising plans and the sale of products in the States, a Design Center to help in developing products that will be acceptable in the world market and a number of financial institutions to mobilize private savings and augment the financial resources on which local manufacturers can draw.

Existing local firms should be able to capture the bulk of the expanding local market, if they modernize production and distribution techniques sufficiently to withstand the competition which our growing market will invite. Some of them should also be able to penetrate new outside markets. Puerto Rican businessmen interested in establishing new plants should, I think, look carefully at the new, locally-produced materials—the synthetic fibres; the textiles; paper from bagasse; solvents for paints; plastics, perhaps reenforced with glass fibre; and at the by-products of meat packing, grain milling, and other new basic industries. Based on such local materials and with the sales, design, and financial support which I hope will soon be available, they should be able to start successful factories capable of competing in the export markets of the world.

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